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An evaluation of non-technical skills development through Emergency Preparedness, Resilience and Response exercises for health sector personnel

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ABSTRACT

History has shown that civilisations are vulnerable to emergencies, whether they are natural or man-made and the actions taken in the initial stages of a response to an emergency are critical. To prepare for these events, the UK National Health Service (NHS) practises its emergency response through Health Emergency Preparedness Exercises (HEPEs).

There is a generally accepted premise that HEPEs impart an *array of* benefits to participants with respect to their capability and capacity to respond in large scale / high consequence emergencies. Crichton and Flin (2004) note that effective emergency response requires personnel to include competence in both normal technical elements and an array of non-technical skills, e.g. team work, communication and leadership skills. While there is widespread recognition of the importance of non-technical skills (NTSs). There is limited consensus over the set of relevant skills for this area (Reedy et al., 2017). Personnel with well-developed emergency response NTSs potentially increases the effectiveness of the collective response (Chalwin and Flabouris, 2013). Kodate et al. (2012) notes that although NTS taxonomies exist, they need augmenting with data from the relevant domain. With a view to addressing this issue, a panel of emergency response experts was recruited and tasked with reaching consensus over defining the set of non-technical skills that NHS emergency personnel should possess. The resultant NTS taxonomy for health emergency response was categorised and named 'Health Emergency Response Integrated non-technical Skills' or HERIS.

Having determined *the* skill set of core NTS, the research moved to assessing the extent to which these skills are reflected in contemporary emergency preparedness exercises; specifically, the NHS's Emergo Train System (ETS) course. The effectiveness of the current NHS ETS course in enhancing participant NTS skills was assessed, using a pre and post design (n=50). Findings revealed that the ETS courses make a positive contribution to elements characterisable under three new skill categories of personal effectiveness, assertiveness and self-awareness.

The research examined the effectiveness of current NHS health emergency preparedness exercises in developing NTS of NHS personnel, the research suggests that HEPEs do impart a level of development of NTS in NHS personnel. Recommendations based on the advancement from the research are advocated to enhance NTS elements within future NHS major incident exercises.

THESIS SUMMARY

This research set out to:

Examine the effectiveness of contemporary health emergency preparedness exercises in enhancing the non-technical skills of NHS staff. This was operationalised though addressing the following research objectives.

(i) Define *the* set of non-technical skills relevant to emergency response.
(ii) Assess the degree to which current NHS health emergency preparedness exercise provision reflects the set of skills detailed at (i).
(iii) Determine participant perspectives on the contribution of contemporary NHS emergency preparedness exercises to their non-technical skill development.
(iv) Make recommendations to improve ETS and, by extrapolation, health emergency preparedness exercises for the effective development of participants' non-technical skills.

Following a review of the literature on: emergency preparedness simulation systems and exercises; non-technical skill development history, nomenclature, taxonomies and measurement, empirical elements were addressed using a mixed methods approach. In the initial study, the nominal group technique (Van de Ven and Delbecq, 1972) was used to characterise expert (*n*=11) perception of headline NTSs.

This produced a set of five health emergency response NTSs: decision-making, leadership, situation awareness, communication and team working. This taxonomy was used as the basis for the question set used to assess participant perspectives on the utility of the NHS Health Emergency Preparedness Exercises (HEPE) course in study two.

Study two used a pre-versus-post design to evaluate participant ratings of their NTS, supporting comment on the effectiveness of the NTS component of NHS HEPEs. The HEPE used was a system called Emergo Train System

(ETS)[1]. ETS is typical of a contemporary HEPE used by the NHS. This provided a subjective measure of the type and extent of NTS developed.

An exploratory factor analysis was performed on the question set generated in study one. This revealed a three-factor structure for characterising participant perspectives on NTSs. Refinement of the three constructs into a set of quantifiable scales allowed formal testing of the degree of homogeneity / heterogeneity in the ratings of the sample.

[1] Emergo Train System (ETS) is a simulation system used for education and training in emergency and disaster management. It is used worldwide and can test and evaluate incident command systems and disaster preparedness.

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KEY WORDS

Emergo Train System (ETS), Emergency Preparedness, Resilience and Response (EPRR), Health Emergency Preparedness Exercise (HEPE), Non-Technical Skill (NTS)

ABBREVIATIONS AND GLOSSARY OF TERMS

ANOVA	Analysis of Variance
AR	Augmented Reality
ANTS	Anaesthetists' Non-Technical Skills
CCA	Civil Contingencies Act
CREW	Crisis Resource for Emergency Workers
CRM	Crew Resource Management
CTA	Cognitive Task Analysis
DHSC	Department of Health and Social Care
ECDC	European Centre for Disease Prevention and Control
ED	Emergency Department
EFA	Exploratory Factor Analysis
EPRR	Emergency Preparedness, Resilience and Response
ERD	Emergency Response Department
ETS	Emergo Train System
EU	European Union
HEPO	Hospital Emergency Planning Officer
HEPE	Health Emergency Preparedness Exercise
HERIS	Health Emergency Response Integrated Non-Technical Skills
HFAS	Human Factors Survey
HM	Her Majesty's
HRO	High Reliability Organisation
HSR	Health Services Research
ILO	International Labor Organization
JAR TEL	Joint Aviation Regulation Translation and Elaboration of Legislation
JESIP	Joint Emergency Services Interoperability Programme

LAS	London Ambulance Service
LLC	Line/LOS Checklist
LOS	Line Orientated Simulation
MBTI	Myers Briggs Type Indicator
MTFA	Marauding Terrorist Firearms Attack
NARU	National Ambulance Resilience Unit
NGT	Nominal Group Technique
NHS	National Health Service
NIHR	National Institute for Health Research
NOTECHS	Non-Technical Skills
NOTSS	Non-Technical Skills for Surgeons
NPFS	National Pandemic Flu Service
NTS	Non-Technical Skills
PD	Professional Doctorate
PHE	Public Health England
RCT	Randomised control trial
RSSB	Railway Safety and Standards Board
SARS	Severe Acute Respiratory Syndrome
SCG	Strategic Coordinating Group
SPSS	Statistical Package for the Social Sciences
TCG	Tactical Coordinating Group
TC	Technical Skill
T & E	Training and Exercising
VR	Virtual Reality
WHO	World Health Organization

CHAPTER 1 - INTRODUCTION

1.1 Overview of the thesis

This chapter presents a contextual background to the topics of emergency planning and non-technical skills (NTSs), it describes the origins of the research, defines the research question and the structure of the thesis. It commences with a summary of the history of emergency planning and the background to the empirical work that is the subject of this thesis. It also details the scope and challenges of the study. The chapter identifies gaps in knowledge that the research aimed to address with detail on the importance of NTSs in health emergency response

1.2 Origins of the research

> It has long been argued in the research literature that conducting *'disaster exercises produce a variety of benefits that promote effective emergency management'. Unfortunately, there are few studies available that confirm this assumption.'*
>
> (Perry, 2004, p1)

The origins of this thesis are encapsulated in the above quote from Ronald Perry. Although research has obviously continued in the interim, a central interest was to test the veracity of Perry's claim with respect to NTSs of the commonly held belief that emergency preparedness exercises are beneficial, but is this true? Perry's work played a central role in shaping initial thoughts on the topic, as well as contributions from other influential thinkers on this topic, notably Flin, Crichton, Helmreich and Peterson.

For the past 19 years, the author has had direct experience of working in Emergency Preparedness, Resilience and Response (EPRR) roles across a broad range of organisations including local authorities, the NHS and Public Health England (PHE). This includes delivery of an extensive range of emergency preparedness exercise types and employment as an Emergency

Preparedness Manager at PHE. From 2009 to 2020, the author was responsible for domestic and international preparedness planning, developing and delivering various types of Health Emergency Preparedness Exercises (HEPEs). These exercises are focussed on developing the NHS, its staff and partner organisations to produce a coordinated response to a variety of emergency scenarios. This experience highlighted the potential importance of effective NTS in preparing emergency response personnel and revealed that research into this topic was limited.

There is a notable consensus that emergency preparedness exercises are beneficial. These benefits may be part of a collective benefit for professional partners, the community, organisational as well as for participants. Beyond increasing familiarity and proficiency with structural and technical elements, a less transparent benefit to participants has been said to relate to the development of NTS, these are important as well-developed NTS are claimed to increase the effectiveness of the collective response see Chalwin and Flabouris, (2013); also see Elliott and Smith, (2006). NTS are a crucial personal element for emergency responders, as they support the effective delivery of technical elements (Flowerdew, Brown, Vincent, et al., 2012). This observation is corroborated by Boyd et al., (2013) who conclude that preparing responders and their organisations was a key research priority.

1.3 Research question

The research question was framed as ‘How effective are current NHS health emergency preparedness exercises in developing/enhancing the non-technical skills of NHS personnel?’ This was operationalised via the following objectives:

- Establish a taxonomy of health emergency response non-technical skills.
- Conduct a survey of health sector personnel to gain an insight into their experiences from participation in ETS.

- Develop a survey-based measure of participant ratings of NTS elements of NHS HEPEs.
- Produce recommendations on ways to enhance NTS elements of NHS HEPEs.

1.4 Structure of the thesis

The thesis is divided into seven chapters:

- Chapter one – Introduction, provides the background to the thesis including the origins of the research, the research question and challenges. The chapter also includes an overview of contemporary UK emergency planning, policy and legislation.

- Chapter two - Literature review, presents a review of published findings on simulation systems and exercises including HEPEs and non-technical skills elements. The chapter provides detail on notable authors in the subject matter, the roots of NTS study through to a review of key NTS publications and previous studies into NTS from a wide range of professionals including healthcare. The review considers the utility of emergency preparedness exercises, sociology in emergency response (psychological profiling and gender) and NTS nomenclature, taxonomies and measurement. The chapter includes a review of the literature on HEPEs, specifically ETS.

- Chapter three – Methodology, referenced to the research aim and objectives, describes the rationale for the research question and considers a range of theoretical frameworks that could be utilised. The chapter provides a critical review of options over method and sampling that were considered and the justification for a mixed methods approach. The research design is described.

- Chapter four – Exploration of expert perspectives on core emergency response NTS. This chapter presents an in-depth review of the

research design for stage one of the research and describes the approach that was taken to data collection and analysis. The chapter describes the findings from this qualitative phase of the study with a discussion of the findings from the data. It concludes with a summary of the key output of the stage.

- Chapter five – Evaluation of participant perspectives on individual NTS development in HEPEs. This chapter presents the context and justification of the method adopted and consideration of the research design for stage two. It describes the approach to data collection and analysis in this quantitative phase of the study. The chapter concludes with a discussion of the findings.

- Chapter six – General discussion, considers the findings from the empirical work. The findings are discussed with reference to published literature on NTS, in particular those relevant to the emergency response context. The chapter builds and elaborates upon the discussion sections in chapter's four and five, with the aim of producing a detailed reflection on findings and the potential contribution of the research to the evidence base on emergency response exercises. It includes a critical reflection upon the limitations of the study, closing with the implications for future policy and practice.

- Chapter seven – Conclusion, this chapter summarises the key findings from the research and arising implications and recommendations for emergency response practice. The chapter concludes with reflection on the contribution of the research, culminating in recommendations for future research. The chapter also includes a reflective component on the personal insight that was achieved from the research.

1.5 Research challenges

With any research there are issues and challenges. This project was no different. As Jenkins (2015) notes, NTS are difficult to measure.

> *'Skills can only be reliably assessed when they result in overt behaviours, and the first problem is that some non-technical skills (such as decision-making) are cognitive, and only become measurable when communicated … in the clinical environment, many non-technical skills are often only apparent in composite behaviours that may be difficult to separate and quantify.'*
>
> (Jenkins, 2015, p898)

However, the fact that it is difficult should not preclude research to explore this area. It is important to understand and articulate the limitations of what is achievable within the confines of this Professional Doctorate (PD). A PD is more limited in scope than a PHD. This is due to length of thesis and research focus on professional rather than academic orientation.

There were other challenges to consider beyond the obvious lack of sufficient familiarity with research methods, experience in research and the use of SPSS. Further, a large quantity of the literature was general 'health and healthcare' and specifically public health and the research was focussed on the skill set required for these professions rather than health emergency response.

1.6 Background and context

> *'Emergency preparedness is an expectation of public health organisations and an expectation of individual public health practitioners*.'
>
> (Gebbie et al., 2006, p73)

The following sections provide a commentary on the background to the development of contemporary emergency response provision in the UK and the broader context of emergency and disaster management, with an emphasis on the role and claims of emergency planning and exercise activity, and debates surrounding the need to address NTSs.

On average Britain experiences three or four major incidents[2] each year (Carley et al., 1998), that have implications for public safety and wellbeing. Boyd et al., (2013) note that '*many major incidents have significant impacts on people's health, placing additional demands on health-care organisations*' (Boyd et al., 2013, p83).

The thesis problematises the definitions placed upon high impact incidents by emergency responders. The terms 'major incident' and 'emergency' are often used interchangeably but each has a distinct meaning in the UK. Down considers that '*incidents are the trigger, the emergency is the immediate aftermath'* (Down, 2016, p1). This is consistent with the definitions and understanding provided within this thesis and with the NHS.

1.6.1 A brief history of the origins of emergency planning in the UK

Current civilian emergency planning arrangements in the United Kingdom have their roots in Civil Defence policy dating from World War Two (1939-1945). However, modern emergency planning and response began at the start of the 21st Century, with a series of large-scale UK-wide emergencies. These were referred to colloquially as the three 'F's: Flooding, Fuel and Foot and Mouth.

The large-scale flooding and the automotive fuel crisis in autumn 2000, and the outbreak of Foot and Mouth Disease in 2001 exposed inadequacies in the existing emergency management arrangements across the UK (Achour et al., 2015). An emergency planning review was therefore instigated by the Deputy Prime Minister John Prescott on 31 October 2000 (Hansard, 2000). The review was ongoing when the four coordinated terrorist attacks by the Islamic terrorist group al-Qaeda against the United States occurred on 11 September 2001. The course of UK emergency planning doctrine and guidance was

[2] A major incident is '*an event or situation with a range of serious consequences which requires special arrangements to be implemented by one or more emergency responder agency*'. (Joint Emergency Services Interoperability Programme (JESIP), 2017). An emergency responder agency describes all Category one and two responders as defined in the CCA (2004) and associated guidance.

affected by these attacks and added a further catalyst for emergency planning changes from the 1948 Civil Defence Act to the Civil Contingencies Act (CCA) 2004. The enactment of the CCA in 2004 along with the accompanying non-legislative measures, delivered a single UK framework for civil protection. The Act is separated into two substantive parts: Part 1 - local arrangements for civil protection; Part 2 - emergency powers (Cabinet Office, 2013). The Act provided, for the first time, a statutory duty for key response organisations to work collaboratively to assess risks and collectively plan for emergencies. These key responders are described (in the CCA) as those organisations defined in the Act as having duties and responsibilities for carrying out the CCA legislation and are designated as category one responders. Category one responders are Police Forces, Fire and Rescue and Ambulance services, Local Authorities and Public Health England. The NHS is a category one responder along with other NHS bodies (Cabinet Office, 2013). There is a further body of organisations designated Category two responders who have a lesser set of duties. These organisations are less likely to be involved in the core planning work but will be heavily involved in incidents that affect their own sector. Category 2 responders are the Health and Safety Executive and transport and utility companies.

There have been a range of large-scale incidents and threats since the enactment of the CCA in 2004. These include the 2005 London bombings; the 2007 UK series of floods; the 2009 pandemic influenza (swine flu) and more recently, a succession of terrorist-related events including suicide bombings, stabbings and vehicle-borne attacks in the UK. These include the Westminster Bridge vehicle-ramming attack (March 2017); the Manchester arena bomb (May 2017) and the London Bridge attack (June 2017) and other large-scale incidents such as the Grenfell tower fire (June 2017) and the Salisbury Novichok poisoning (2018). However, there have been no further large-scale changes to the fundamental emergency planning approach or legislation since the enactment of the CCA in 2004.

1.7 Emergency planning

> '*The art of emergency planning involves "anticipating the unexpected".*
>
> (Alexander, 2015, p10)

Dwight D Eisenhower is quoted as saying '*Plans are worthless, but planning is everything*' (Eisenhower, 1957, p1). This quote is included not to downplay the importance of plans but to emphasise the process of planning. He is also quoted as saying '*there is a very great distinction because when you are planning for an emergency you must start with this one thing: the very definition of "emergency" is that it is unexpected, therefore it is not going to happen the way you are planning. The details of a plan which was designed years in advance are often incorrect, but the planning process demands the thorough exploration of options and contingencies. The knowledge gained during this probing is crucial to the selection of appropriate actions as future events unfold*' (ibid).

This thesis does not advocate not producing emergency plans but endorses emergency planning as a process rather than a product and it is the unknown nature of what may occur that requires the application of rigour and an organised approach. Lee Clarke (1999) observes that '*when organizations plan they construct a map of which contingencies are considered to be more relevant. The very act of mapping gives some structure to the "data", ordering what could otherwise be a very chaotic world*' (Clarke, 1999, p8).

A number of terms are used to describe the process of planning for emergencies (including major incidents) or disasters to achieve a level of preparedness (Quarantelli, 2000). These include emergency management (FEMA, 2013), emergency preparedness (Cabinet Office, 2012) EPRR (NHS England, 2014) and emergency planning. Alexander (2015) defines emergency planning as '*an exploratory process that provides generic procedures for managing unforeseen impacts and should use carefully constructed scenarios to anticipate the needs that will be generated by*

foreseeable hazards when they strike'. *(*Alexander, 2015. p1). There are other generic terms such as crisis management, disaster management or planning and Civil Protection. Despite, each term focussing on various aspects of the response including business, organisational and humanitarian vulnerability, the terms are routinely used interchangeably.

Within this thesis, the term emergency planning will be used and will conform to the definition from the Civil Contingencies Secretariat (CCS) of emergency planning as an '*aspect of Integrated Emergency Management*[3] *concerned with developing and maintaining procedures to prevent emergencies and to mitigate the impact when they occur'* (UK Government, 2013, p221).

There is also an element of scale and magnitude in the planning for, and the response to, an emergency and therefore the resources required to plan and respond to the event (Alexander, 2015). The Federal Emergency Management Agency (FEMA) describes the scale of planning and response as a 'continuum of magnitude' (FEMA, n.d.). FEMA describes the continuum as ranging from an emergency, to disaster, to a catastrophe, to an extinction level event. The level of planning represents the highest level of crises for which planning can make a difference; above a certain level of planning and response, such as an extinction level event are beyond an effective organised response and are not a reasonable use of resources. Bartley et al. states that '*hospital disaster preparedness presents complex clinical, operational, and philosophical challenges. It is difficult to determine how much time, money, and effort should be spent on preparing for an event that may not occur*' (Bartley et al. 2006, p250). The thesis will consider up to the level of emergency for planning and response.

In addition to understanding what emergency planning is, there is a need to plan for and respond to an emergency. To do this, an organisation first needs a definition of an emergency to be able to assign resources appropriately.

[3] The fundamental elements of this concept are; assessment; prevention; preparation; response and recovery (Cabinet Office, 2003). The new fundamental of anticipation was added with the introduction of the Civil Contingencies Act (CCA) (2004).

The CCA defines an emergency as:

> '*An event or situation which threatens serious damage to human welfare in a place in the UK, the environment of a place in the UK, or war or terrorism which threatens serious damage to the security of the UK' From the Contingencies Act 2004'*
>
> (Cabinet Office, 2004, p3)

1.7.1 Legislation – Civil Contingencies Act

The overarching emergency planning legislation applicable to the NHS is the Civil Contingencies Act (CCA) (2004). Under the CCA legislation, National Health Service (NHS) bodies are designated as Category one responders[4]. The CCA prescribes what NHS bodies are expected to plan and prepare for. The Act expects NHS organisations and providers of NHS-funded care to plan for, and respond to, a wide range of incidents and emergencies, while simultaneously maintaining essential health services.

The CCA introduced specific responsibilities applicable to all Category one responders. The NHS, as a category one responder along with other NHS bodies, the emergency services, Public Health England and Local Authorities are at the core of the response to most large-scale emergencies e.g. terrorist attack, transport incidents or a disease outbreak such as pandemic influenza. Under the provisions of the CCA, NHS hospitals are required to demonstrate their preparedness by ensuring staff are appropriately trained, resourced and are familiar with emergency plans and arrangements to ensure an effective response. The focus is on a single framework to enable a national response. Planning is directed at diverse hazards and risks. These hazards and risks cover both natural and man-made events of national and potentially worldwide impact/consequence. Considerations include international terrorism, climate change and pandemics.

[4] An emergency responder agency describes all Category one and two responders as defined in the CCA (2004) and associated guidance. (Joint Emergency Services Interoperability Programme (JESIP), 2017). The other Category one responders are: All Local authorities, Police forces, Fire services, Ambulance services, Port health authorities and the Environment Agency, HM Coastguard and Public Health England

Further, to ensure that the NHS can fulfil its legal responsibilities, it undertakes planning and response activity, referred to as Emergency Preparedness, Resilience and Response (EPRR). This emergency planning environment is intended to provide a robust programme of work. The EPRR requirements are articulated in the NHS England Emergency Preparedness, Resilience and Response Framework (2015), which is heavily referenced in this literature review. The document provides the framework for all NHS funded organisations in England to meet the requirements of the CCA (2004). The framework aim is '*to enable the NHS in England to ensure effective arrangements are in place to deliver appropriate care to patients affected during an emergency (as defined by the CCA 2004) or incident*' (NHS England, 2015b, p7). NHS England plays a key role in the EPRR process and leads the National Health Service in England, setting the priorities and direction of the NHS including that for health emergency preparedness. EPRR includes risk assessment, emergency plan production, information sharing (communication), staff training and conducting HEPEs.

NHS England's EPRR framework directs that NHS Trusts should have a live-play exercise with a minimum frequency of once every three years. This is described as *'a live test of arrangements and includes the operational and practical elements of an incident response'* (NHS England, 2015, p25). HEPEs are a core component in compliance and ensuring staff have a familiarity with emergency response arrangements and are the culmination the EPRR programme of preparedness that the NHS must undertake.

The environment within which the NHS operates is complex (Burgess and Radnor, 2012). This complexity introduces conflicting tensions regarding service resources. It is necessary for the NHS to prepare for, and respond to, a wide range of major incidents and emergencies that could affect service delivery or patient care. The Cabinet Office (2004) requires NHS organisations, and providers of NHS-funded care to show that they can manage such incidents while simultaneously maintaining normal services.

There is additional statutory legislation that impacts upon the preparedness activity of the NHS. The NHS Act 2006 requires NHS England to ensure that the NHS is properly prepared to deal with an emergency. Key elements of the Act are contained in Section 252A and include monitoring compliance and facilitating a coordinated response.

There is a significant amount of emergency preparedness guidance which covers the more detailed health emergency planning and policies. These include Emergency Response and Recovery (UK Government, 2013) and the guidance attached to the CCA, 'Emergency Preparedness' (Cabinet Office, 2012). The emergency preparedness guidance aims to establish good practice based on lessons identified from responding to and recovering from emergencies.

1.8 Health emergency preparedness, resilience and response

> *'Due to the uncommon nature of large-scale disasters and emergencies, public health practitioners often turn to simulated emergencies, for preparedness assessment and improvement.*'
>
> (Hunter et al., 2012. p1)

Stoto (2013) states that public health emergencies are rare and Carley and Mackway-Jones state that '*although major incidents are uncommon, they require careful planning and preparation if they are to be managed well*' (Carley and Mackway-Jones, 1996, p1242). Incidents do occur and there are numerous examples of real events involving the NHS either directly or indirectly. These include the London bombings in 2005 (case study #1 – Appendix A1); series of UK summer floods in 2007 (case study #2 – Appendix A1); a series of hospital fires in London in 2008-9 (Wapling and Philpott, 2009) and the swine flu outbreak in 2009 (case study #3 – Appendix A1). More recent examples are a series of terrorist-related incidents both in the UK and abroad. These include the Paris attacks in November 2015; the Brussels bombings in March 2016; and the Nice vehicle-ramming attack in July 2016. In the UK: the Westminster Bridge vehicle-ramming attack in March 2017; the

Manchester arena bombing in May 2017 (case study #4 – Appendix A1); the London Bridge attack in June 2017 and other large-scale incidents including the Grenfell tower fire in June 2017 and Salisbury Novichok poisonings in 2018. All these major incidents required significant health emergency response at receiving hospitals and across the NHS. Hospitals are required to prove their preparedness for these types of situations including staff familiarity with emergency response arrangements and that personnel are trained and resourced appropriately (NHS England, 2015b). An appendix of relevant UK case studies of key incidents with associated timelines are included at appendix A1. The case studies selected best represent a range of key incidents (2005 to 2017) and a) had national reviews commissioned post incident and b) were of sufficient size and currency to review.

Most major incidents have casualties associated with them, however the scale varies. Casualties from incidents will generally be taken for treatment to the nearest (or most appropriate) Accident & Emergency department. NHS Accident & Emergency departments are the portals into the NHS system and it is these gateway locations that train and prepare for major incidents and emergencies. Failure in their response could adversely impact upon casualty outcomes and, in the worst case, increase fatalities. It could also negatively impact upon the reputation of the NHS.

1.8.1 Health emergency policy and standards

The NHS England EPRR framework lists nine types of incident, from a '*rising tide*' incident such as a developing infectious disease epidemic to a mass casualty event with hundreds of casualties. In addition, the NHS recognizes three classes of incidents. They are Business Continuity, Critical and Major. Each will have an impact upon service delivery within the NHS. Within this thesis, the NHS definition of a major incident will be adopted, as it also includes any event defined as an emergency. The NHS definition of major incident is '*any occurrence that presents serious threat to the health of the community or causes such numbers or types of casualties, as to require special arrangements to be implemented*' (NHS England 2015b, p9). This is

consistent with the Joint Emergency Services Interoperability Programme (JESIP) definition of a major incident and the CCA definition of an emergency.

NHS organisations and providers of NHS funded care are expected to achieve a minimum core standard across a range of EPRR requirements. These core standards are designated in the NHS England Core Standards for EPRR (NHS England, 2018). There are 69 core standards detailed covering governance, risk assessment, maintenance of emergency plans, communicating with the public, information sharing, cooperation and training and exercising. Core standard 27 states that emergency plans should be validated through a '*six-monthly communications test, annual table-top exercise and live exercise at least once every three years'* (NHS England 2018, p3). These exercises (HEPEs) are included in the NHS EPRR programme. HEPEs are the culmination of the EPRR programme of preparedness and are an important part of preparing NHS personnel for real incidents.

1.9 Chapter summary

This chapter provided an account of the origins of emergency planning and an overview of the research by providing context and background for the subject matter and the structure of the thesis. It outlined the research origins and research question.

Key elements of the chapter were:

- The origins of the research were prompted by the commonly held belief that emergency preparedness exercises are beneficial. A benefit to participants is said to be the development of non-technical skills (NTS), these are important as well-developed NTS are claimed to increase the effectiveness of the collective emergency response.

- Although major incidents and emergencies are uncommon, recent terrorism related incidents have required a health emergency response which requires a planning process to prepare health personnel.

- The NHS works within an emergency planning environment intended to provide a robust programme of work referred to in Health as Emergency Preparedness, Resilience and Response (EPRR).

The next chapter reviews the available literature on the topic to provide detailed context for the research.

CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

This chapter set out to review and synthesise the literature on NTSs, specifically, evidence relating to their nature, relevance and role within the emergency response context, as well as the implications for personnel training and development. As such, it provided the background and direction for the design of empirical elements of the research.

The literature review revealed that contemporary research findings could be categorised as reflecting six related themes:

a) The utility of emergency preparedness exercises including an overview of ETS
b) NTS development history and relationship to NTS in HEPEs and leading figures in the field
c) Sociology in emergency response; psychological profiling and gender
d) NTS nomenclature
e) NTS classification taxonomies including comparison of existing taxonomies and relationship to HEPEs
f) Measurement of NTS

Each will now be discussed in turn.

2.2 Utility of emergency preparedness exercises

> '*Emergency preparedness exercises are planned and executed to make sure everyone has in-depth training and practice experience with different incident scenarios, equipment and environments. Actual incidents are extremely rare, so simulations are crucial in keeping employees' response skills sharp and ready at a moment's notice'*.
>
> (Canadian Energy Pipeline Association, 2018, p1)

The starting point for the review was a critical appraisal of historic and contemporary emergency preparedness exercise and simulation systems in their various manifestations to assess their utility. In the introduction to thesis, the question was asked 'Are exercises beneficial?'. This section will review the evidence on the utility of (health) emergency preparedness exercises and simulations. The terms emergency preparedness exercise and simulation exercise are widely used interchangeably, despite differences in definition being the subject of notable debate. Krishnan et al., for example, defines a simulation as '*the artificial representation of a real-world process with sufficient fidelity in order to facilitate learning through immersion, reflection, feedback and practice without the risks inherent in a similar real-life experience'* (Krishnan et al., 2017, p84). An exercise is defined broadly by the Cabinet Office as '*raising participants' awareness about the potential emergency that they may face and giving them confidence in the procedures and their ability to carry them out successfully*' (Cabinet Office, 2011, p52).

The terms can be used interchangeably within different organisations and are considered broadly similar in this context, as they are events that provide mock situations for participants to interpret and respond to in a safe environment. Within this thesis, the term health emergency preparedness exercise (HEPEs) will be adopted as this is the convention in the NHS EPRR field (Skryabina et al., 2016).

HEPEs are the culmination of the NHS EPRR programme of preparedness and are an important part of preparing NHS personnel for real incidents. Biddinger et al., notes that public health agencies have '*increasingly turned to exercises that simulate emergencies*' (Biddinger et al., 2010, p101). It is these exercises that provide the final element of the EPRR programme aimed at maximizing NHS readiness for managing major incidents and emergencies. NHS England state that '*through the exercising process individuals have the opportunity to practice their skills and increase their confidence, knowledge and skill base in preparation for responding in a live incident'* (NHS England, 2015b, p24).

A primary reason for conducting an emergency response exercise is to prepare personnel for what they may face in real incidents, but in a simulated and safe learning environment (Murray et al., 2008) where personnel can prepare and learn from errors within the safe space where no one is at risk from a bad or wrong decision or action.

A number of studies have explored the effectiveness and benefits of exercises. These include Agboola et al. (2013), Savoia et al., (2009), Riley et al., (2012), Peterson and Perry (1999), Borodzicz and van Haperen (2002) and Perry, (2004). These authors contend that there is widespread acceptance of the claim that emergency preparedness exercises produce a variety of benefits, asserting that emergency preparedness exercises aid in developing working relationships, testing training programmes and are an opportunity for 'hands on' experience of emergency equipment, procedures and protocols.

The function of emergency preparedness exercises and how they are developed and delivered has not changed much since the 1940s. However, there are only so many ways of configuring these types of event. The most commonly encountered traditional formats are discussion workshops, table or desk-top, command post and live-play or field exercises.

Some incidents may be so rare that they require planning and preparation; an exercise will enable this preparation to be undertaken without having to wait for a real event. However, exercises are simulations. Attempts to add realism have been undertaken, for example, the use of features such as mock news broadcast and casualties 'moulaged' with false blood and missing limbs. However, at a fundamental level, the fact that participants are aware that they are not dealing with a real event and that there are no consequences arising from their actions remains. An arising implication is that participants may not engage fully with the exercise. In recognition of this, 'live' field exercises are widely regarded as the 'holy grail' of emergency response familiarisation (Riley et al., 2012), However, recent years have witnessed the emergence of an array of technologies that lay claim to enhancing the realism of exercises, e.g. the use of virtual or enhanced reality and the use of simulator systems.

These have been used both as substitutes for and adjuncts to traditional field exercises.

Ford and Schmidt, (2000) claim that emergency preparedness exercises require the generalisation of the specific conditions of an exercise to accommodate the running of simulation compared to the actual conditions of a real emergency i.e. the situation is artificially created and does not have all the same pressures, activity and reality of an actual emergency. These authors state that a compromise is required to allow the running of an effective simulation. For example, the creation of mechanisms to create a high workload through elements such as injects. Injects are discrete pieces of information that guide the participants towards achieving the exercise aim. According to the European Centre for Disease Prevention and Control (ECDC) handbook on simulations exercises in European Union (EU) public health settings, they can be in the form of phone calls, emails simulated report pseudo media items such as newspaper articles (Vasconcelos, 2014). The mechanisms create time pressures to simulate real incident response stress and activity levels. However, this can create a lack of realism for the participants, which is obviously not the desired effect as designers of exercises strive to achieve the highest level of realism possible within the resources available. It can be difficult to generate the 'real' pressure through genuine pathways, i.e. direct from control centres or on-scene commanders through injects.

Ford and Schmidt also state that '*effective generalization of skills learned in training to the significantly different demands that could arise in an actual emergency*' (Ford and Schmidt, 2000, p199) could be considered sub-optimal, i.e. as the situation is artificial, it is possible that the demands the simulation generate are not precise representations of the real event. While Lateef (2010) challenges this claim of exercises being sub-optimal, stating that '*Simulation-based learning can be the way to develop health professionals' knowledge, skills, and attitudes, whilst protecting patients from unnecessary risks*' (Lateef, 2010. p1).

Ford and Schmidt suggest '*the problem of generalization can be overcome by providing opportunities for guided discovery learning, incorporating error-based learning activities into training, and providing for the development of metacognitive skills*' (Ford and Schmidt, 2000, p205). They suggest a range of strategies to address these shortfalls in the delivery of an exercise which include the promotion of active learning and guided discovery, but importantly they speculate that skills can by developed through providing exercises.

Smith et al., (2012) state that '*disaster simulations have been a historical cornerstone of catastrophic incident preparedness testing and improvement and are considered a fundamental tool for enhancing both regional and institutional readiness*' (Smith et al., 2010, p158). Wallin et al, mention that '*full-scale simulation training is an accepted learning method for gaining behavioural skills in team-centred domains*' (Wallin et al., 2007, p173)

However, some authors challenge claims surrounding the utility of emergency preparedness exercises. Bartley et al., (2006), for example, conclude that their '*comprehensive, literature review failed to find any substantial scientific data proving the benefit of these* traditional emergency response exercises, as they are *'resource and time-consuming exercises*' (Bartley et al., 2006, p249). However, these authors go on to conclude that although exercises may be time consuming they are worthwhile for the individual.

Some simulation systems use traditional media such as videos, role play or discussion-based scenarios, such as those cited by Wallin et al., (2007) and Yee et al., (2005). However, current simulation systems are trending towards more interactive or immersive computer-based systems and/or require specialist equipment such as human patient simulators. There are many healthcare and related simulation-based systems available, both commercial and those devised, developed and delivered by healthcare organisations. Examples include US based systems such Simul8[5], AnyLogic[6], FlexSim[7] and

[5] Simul8 uses animation to help validate and communicate the issues and use the reporting tools within simul8 to analyse the results. The process being modelled may be a clinical testing procedure or an A&E facility.

[6] AnyLogic simulation software is a tool using Java to enable users to create portable web-enabled models which will run on any Java-enabled platform and can be placed on a website

SimCapture[8]. UK based systems include such systems as Train-station, which was developed by National Ambulance Resilience Unit (NARU). This software allows course delegates to share and learn from each other simultaneously during classroom exercises. Conducttr is a scenario-based team training tool using a mixed-reality platform. There are also specialist companies offering their services such as Vector Command Ltd offering incident management software solutions for command and control operations and training.

However, traditional formats such as discussion based, table-top and field exercises remain the most prolific types of exercises conducted (McDarby et al., 2019). What is changing are the incremental additions such as technologies, the use of which is claimed to enhance traditional exercises such as the use of Augmented Reality (AR) and Virtual Reality (VR) which are finding their way into areas of the public sector including Health routinely, justified on grounds of improving the efficiency of public services (Briggs et al., 2019). *The virtual environment offers the trainees the ability to interact and experiment with items and constructs in a similar way they would do in real world'* (Mekacher, 2019, p118). A facility that is crucial in the world of emergency planning.

These technologies are also tending to be used as replacements for the traditional style of exercise, as these new types of format are claimed to give a full and immersive experience which can add value to the personal experience (Fehling et al., 2016). Online training is now a popular choice as it can be cost effective and allow participants to learn at their own pace. However, the process has a series of challenges such as it can leave the participant detached from the experience through minimal in-person contact, it requires self-motivation and time management and is susceptible to network and technology failures (Strayer University, 2019). The increased dependence on this type of training, it might be surmised, may be driven by

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[7] FlexSim is a PC based, object-oriented, simulation tool used to model, simulate, and visualise processes and has been developed to allow users to build models directly in a 3D environment. This is used by John Hopkins Hospital, Baltimore.

[8] SimCapture accepts inputs from virtually any medical device and supports a broad range of camera inputs. The system allows for extensive capture combinations of camera angles, scopes, patient monitors and ultrasounds.

financial constraints, particularly in public sector areas in addition to an ever-growing convention for remote working and access from wherever a person is located. However, detractors consider online and remote access simulations and detached exercises a poor substitute for a full-scale or in person simulation. Elliott and Macpherson (2010) contend that because a real emergency response, particularly in a hospital setting, will be in person and not through a video feed or via a computer game that '*to achieve competent practice depends on becoming better by doing; there is little or no time to practice during a crisis*' (Elliott and Macpherson, 2010, p580).

The use of alternative media is relatively new within this field (Hsu et al. 2013), but new technologies have been used in other areas for more than two decades. Hsu et al (2013) notes that '*Virtual Reality (VR) environments appears promising in its ability to bridge the gaps of other commonly established training formats'* (Hsu et al., 2013, p1). The relative merits of a traditional exercise compared to these newer techniques will be explored.

The literature contains extensive claims regarding the advantages of traditional exercises, e.g. it can provide a safe environment for people to participate and prepare in for rare and critical events (Jonson et al., 2017). As noted earlier, simulations provide a risk-free area in which a person is be able to take decisions/actions with impunity, knowing there are no real consequences from a making a bad or wrong action or decision. Practical exercises can provide valuable hands on experience of response equipment and protocols (Hsu et al., 2006). Dr Shirts, the founder of Simulation Training Systems[9] is well known for his pioneering work in experiential training. He recommends that a number of elements should be considered when attempting to create a successful simulation. His recommendations include: keeping exercises simple, managing participant emotions, keeping to the rules, adding appropriate realism, considering the right method to assess performance, testing the exercise in advance and setting a standard for success. He suggests that these would all enhance the chances of delivering a successful simulation.

[9] STS was established in 1969, the company designs and produces training programs for businesses and government agencies

One area that technologies such as VR have claimed to have an edge on traditional exercises is by providing a higher level of realism (Cid, 2017). This can be a significant limitation of a traditional exercise such as a table-top style. Some of this is due to the costs involved in simulating real events. Only a field or live exercise come close to providing the same level of realism and the costs can be prohibitive to achieve this. Proponents of VR claim that their systems can provide this immersion as they '*can better approximate real life conditions while retaining the advantages of a controlled environment*' (Hsu et al., 2013, p3). VR can also do this in the simulated environment at a fraction of the cost (Wentworth, 2018). However, VR also exhibits a number of practical limitations, including a lack of familiarity with the technology and initial capital costs for the equipment or to hire the system (Hsu et al., 2013). Further, if the system has been purchased there may well be on-costs to keep the system up to date in terms of software and adapting and updating and creating new scenarios.

An additional advantages of VR is the provision of a safe environment (Chen et al., 2008), which can be provided by traditional exercises, but it may be argued, there is more control with VR, where the simulation can be simply switched off. By the nature of VR, individuals are immersed in their own world and although they may interact with others within the simulation, it would not be a true group activity. There are many visual clues from other participants in a traditional exercise (Sexton, 2004) through the face-to-face interaction of people to enable a person to perceive emotions and body language that are not available in a VR simulation (Hsu et al. 2006). However, tradition exercises generally limit participant interaction to the immediate vicinity of the exercise, whereas arguably new technology expands those horizons to offer the potential for wider geographic collaboration and interaction.

Reflecting upon evidence of the relative merits of traditional exercises compared to technologies such as VR, it may be inferred that each has limitations. However, there seems to be intuitive value in combining the strengths of each, i.e. to enhance traditional approaches.

2.2.1 Purpose of emergency preparedness exercises

HM Cabinet Office describes three main purposes of emergency preparedness exercises:

a) To validate plans.
b) To develop staff competencies.
c) To test well-established procedures.

The Cabinet Office considers it important to hold exercises as planning for emergencies cannot be considered reliable until it has been exercised and has proved to be workable (Cabinet Office, 2013). Skryabina et al. (2016) notes that exercises are generally designed and delivered for organisational benefit to test emergency response systems. It is assumed that individuals, by taking part in one of the four traditional format exercises (discussion workshops, table or desk-top, command post and live-play or field exercises), gain some value at an individual level including development of their skills.

Van Haperen claims that outcomes may vary, stating that '…*dependent on initial knowledge, experience and personality different individuals possess different base skills and competencies, and it is at least uncertain whether each individual's training requirements could be accommodated and met'* (van Haperen, 2001, p46). This is a claimed limitation of simulation exercises. Van Haperen further notes that '… *there is also the risk that scenarios for such training events may lead to complex simulations that are difficult to administer and are poor learning vehicles. Hence doubts are raised about the effectiveness of those exercises that aimed to achieve learning at different levels. Not only is it difficult to combine individual and organisational learning from an educational or training perspective, but even if it appears to be possible such exercises may simply not be cost-effective*' (ibid, p40). Lurie et al note that exercises can be expensive to organise and deliver (Lurie et al., 2006). Although Forrest et al., (2013) contend that a cost effective way to deliver a live-play exercise is to use a simulation system (Forrest et al., 2013). Borodzicz and van Haperen (2002) note that '*simulation exercises provide the only experiential means by which to train people in an environment that is as*

realistic as possible for an as yet unknown crisis' (Borodzicz and van Haperen, 2002, p139).

Assessing the quality of an exercise can be problematic, Borodzicz and van Haperen (2002) note the difficulty in defining and measuring outcomes in emergency preparedness exercises. It may be reasonable to speculate that it is about the people and if they feel better able to respond in an emergency situation. Ultimately, the quality and benefit added by participation in an exercise will not be known until a real event is responded-to and the outcome is known. However, it may be a different outcome for different people, dependent on the degree of engagement with the exercise as well as levels of experience and training (van Haperen, 2001). There are notable logistical barriers to comparing one exercise medium with another e.g. table-top versus command post versus field exercise.

Published evidence on the utility of exercises, reveals notable consensus that emergency preparedness exercises provide a viable means to simulate a real event (Borodzicz and van Haperen, 2002). Moreover, the majority of studies hold that there is benefit in participating in exercises while acknowledging that there are also limitations.

The evidence reviewed in this section indicates that exercises, although having limitations such as lack of realism, do provide a level of utility and Perry's 2004 statement about widespread acceptance of the claim that emergency preparedness exercises produce a variety of benefits receives notable support.

2.2.2 Interconnectivity of exercises to emergency planning cycle

An important distinction in health emergency preparedness is between exercises and training. The terms Training and Exercising (or T & E) are commonly joined as they are closely linked; in fact, the author's own department in PHE is called Exercises and Training. NHS England also combines the two in the EPRR core standards. The author contends they are separate activities. There is support for this within the literature. Perry

(2004), for example, makes the distinction *'…emergency managers have appealed to a long-held vision of creating preparedness: first plan, then train, then exercise*'.

The Cabinet Office (2012) CCA Emergency Preparedness publication is a fundamental emergency planning text. Figure 1 shows the Cabinet Office's 'eight stages of emergency planning'. The cycle has two interconnected cycles covering consult and embed phases. The cycle clearly separates training (stage 6) from exercising (stage 7). They are portrayed as distinct entities in the eight-step cycle.

(Cabinet Office, 2012, p17)

Figure 1. The eight stages of emergency planning

This separation of entities is supported by Wrightington, Wigan and Leigh NHS Trust who maintain that '…*it is important that people taking part in exercises should be trained beforehand. Participants should have an awareness of their roles and be reasonably comfortable with them, before they are subject to the stresses of an exercise*' (Wrightington Wigan and Leigh NHS Trust, 2007, p1).

Training is preparation, without which participants may feel personally under prepared and may under-perform in the exercise. Exercising is validation or

confirmation (testing) of the training. This assertion is supported by Lee et al. (2009). Their publication notes that '*organisations now hold exercises, in order to test how they would respond to particular sets of circumstances*' (Lee et al. 2009, p272). Perry (2004) states that '*exercises represent constructed opportunities to test the protocols and equipment specified under a plan'* (Perry, 2004, p66).

That is not to say that exercises are not sometimes used by organisations as a training opportunity. An exercise may be thought of as training when for reasons such as lack of time or resource; little or no training has been conducted prior to the exercise. Then there is no choice but to use the exercise as training, but this is not the ideal. There is also the possibility of lazy language in that people call this activity training as they do not discern a difference. Following the eight steps in the order presented in Figure 1 should provide the validation, development and testing that a HEPE was designed for. For the purposes of this research, the distinction is important; an exercise is not training and is the position adopted in the research. Training will not be considered in this research.

Accepting that the literature suggests that emergency preparedness exercises have utility for participants and understanding the distinction between training and exercises, there is a major difficulty in comparing one form of exercise with another in a meaningful way. It has been mentioned that a live or field exercise is considered the most desirable due to the closeness of this type of exercise to be able to provide a level of realism for participants. Shirt (1992) suggests this type of small-scale replica of the full-blown reality may not be the best option for soft skills development (Shirt, 1992). The Cabinet Office assesses that live exercise provide a test of 'physical capabilities', which cannot be achieved in a table-top exercise. Scott et al (2006) notes that interactive simulations increased the technical skills required for a terrorist response (Scott et al. 2006). However, for the development of NTS, those exercise with a more people focussed interaction approach may be more adept as promoting development of NTS.

VR type simulations tend to isolate participants from the, at times, subtle 'real-world cues' that are evident in person to person interactions, e.g. confidence or nervousness. Crichton and Flin (2001) suggest low fidelity 'role-play' type traditional exercises can be effective for developing NTS. However, Cohen et al., (2013) state in their study of using novel virtual environments, that they had established the reliability of a virtual environment to develop NTS (Cohen et al,. 2013). However, Cohen et al's study had a small sample size (*n*=23) and the study's conclusion stated that there was no significant correlations between the expert assessment and self-assessments of non-technical performance in the study intervention. This may indicate that while virtual environments are viability alternatives to traditional exercises they still lack the important element of genuine person to person interactions.

This may lead to the assumption that although new technologies such as VR and virtual environments have much to add to the delivery of emergency preparedness exercises, more traditional exercise particularly role-play type exercises may be more effective at developing NTS.

2.2.3 The Emergo Train System

As mentioned in the introduction to the thesis, a system called Emergo Train System was the focus for the evaluation in the present study. This system is widely used by the NHS. ETS is a simulation exercise used to test and evaluate incident command systems; as a mechanism to test plans; used to develop participant skills; and assess organisations' procedures in a repeatable, controlled and safe environment.

ETS was developed in Sweden in the mid-1980s at Linköping University. The basic set up of the system is simple, using a whiteboard and magnetic symbols (which are part of a purchased set of kit) to represent an incident. The boards can represent a hypothetical scene with emergency services responders and other boards can represent the receiving hospital with an emergency department, theatres, ICUs and hospital wards. Manipulatable variables include staff available and additional resources and can show in-hospital patients spread across the hospital. Casualties are represented with

‘puppets’ in the form of a magnetic symbol. They provide a range of patient information and potential outcomes dependent on the interventions (surgical procedure, medication or intubation) and the times they would ideally be applied. For example, the requirement for surgery within two hours of admission. Failure to move a patient to an operating theatre in the time frame indicated could result in an unfavourable outcome for the patient which can be evaluated. The system focusses on the management of casualties from the scene and patients in a healthcare setting. The system adds realism using casualty outcomes pre-determined by timing and access to appropriate treatments. This makes it possible to evaluate the response.

As at July 2019, there were approximately 2,000 certified ETS Senior Instructors[10] and over 100 Educators[11] in 39 countries delivering these types of exercises. The countries include United Arab Emirates, Japan, Australia and Korea. The system is used similar ways in each country according to the universal training given as part of the instructor training regime. ETS has been used as an intervention in a similar context to this research for head nurses in an emergency department in Sweden (Jonson et al., 2017). However, Jonson’s study looked at individual self-efficacy and initial task related incident management rather than individual NTS development.

The features of a good exercise have been said to include elements such as provision of a realistic and a safe environment; an opportunity to get ‘hands on’ experience to build confidence and that responses are based on existing procedures and resources (Pan American Health Organization, 2011). Further, that an element of role play has been claimed to aid NTS development (Crichton, 2001). The ETS system has aspects of these for participants along with some limitations.

The ETS system has been said to lack realism, as it is an analogue low-fidelity simulation tool (Rybing et al., 2016), placing a heavy reliance on

10 A senior (ETS) instructor is the head instructor in an ETS simulation exercise. He/she is responsible for setting the course objectives and ensuring they are achieved.

11 Educator level is a continuation of the Senior Instructor course. A certified ETS Educator can start an ETS faculty and run senior instructor courses. The author is an ETS Educator.

participants imagining the emergency situation. The system is not physically embedded in the hospital environs or at a simulated scene and it relies upon cognitive participation and uses in particular, the logistical and process elements of the response to represent the incident. However, ETS is eminently adaptable to almost any scenario and setting (Queensland Government, 2015) and is supported by an extensive casualty database to support a wide range of scenarios. It is considered low-cost and ideal for a resource limited environment (Leow et al. 2012).

Participants benefit from having direct experience of their department, its role and how it operates. Most participants will generally have had experience of their department and its capability and capacities. However, ETS is not immersive in the same way as the virtual systems discussed previously, due to the cognitive nature of the system.

This type of simulation system has been claimed to have several advantages which include improving learner commitment; supporting repetitive practice; providing a means of adjusting training difficulty to match learner objectives and that the outcomes can be used as a basis for after-action reviews (Rybing et al. 2016). Other strengths of ETS include the person to person interaction in a role-play style which has been showed to help develop NTS. Further, the system allows a degree of 'hands on' experience of managing the incident casualties in the form of magnetic representations that can be moved around the hospital. Also, the process that the participants follow is based on their current procedures and protocols.

From this it can be inferred that ETS, like most simulations systems has limitations but does include the key element of role play which has been shown to aid in the development of NTS in an exercise process (Crichton et al, 2001). This would suggest that the system will be useful as an intervention to evaluate NTS development in participants.

2.3 Non-technical skill development history

To set out the basic tenet for the research, it is key to understand why NTS are crucial for emergency response personnel. Rasmussen et al, (2019) states that '*deficient non-technical skills (NTS) among providers of critical care … is a threat to patient and operational safety*' (Rasmussen et al., 2019, p1). Well-developed NTS for emergency responders have been said to enable health professionals to conduct their technical skills with more competence; contribute to safe and efficient team performance (Flowerdew, Brown, Vincent, et al. 2012); reduce/limit the number of adverse events that may occur during a response and increase net the effectiveness of the collective response.

The origins of modern non-technical skill (NTS) theory can be traced to research into aviation accidents in the 1970s, such as the Tenerife airport disaster in 1977, and the human contribution to accidents. As a result of the spate of accidents, the Crew Resource Management (CRM) (Helmreich et al. 1990) technique was developed with the aim of improving flight safety and minimizing accident rates. NTS practice, categories and component elements have their roots in CRM. CRM is widely cited as the basis for airline CRM behavioural markers (Flin and Martin, 2001). These were used to evaluate a crew's performance rather than an individual. CRM is a set of a fundamental NTS associated with relevant behavioural markers, which are a prescribed set of behaviours indicative of some aspect of performance. CRM uses ratings within six categories of behaviours. These are:

- team management and crew communications
- situational awareness and decision making
- automation management
- special situations
- technical proficiency
- overall observations

These categories give 28 behavioural markers rated on a 4-point scale ranging from 1 (poor), 2 (minimum expectations), 3 (standard), to 4

(outstanding) (Helmreich et al., 1997). Using the fundamentals from CRM, other domains have adopted the approach (Kodate et al., 2012). Possession of effective NTSs is recognised as an important skill for emergency responders, particularly High Reliability Organisations (HROs) (Crichton and Flin, 2004). HROs are organisations that operate in conditions that embody the potential for large-scale risk and harm, but they have succeeded in achieving high resilience to failure in an environment where normal accidents can be expected due to risk factors and complexity. HROs have adopted and adapted the NTS beyond aviation in to other high risk areas such as surgical and neonatal resuscitation teams to enable these teams to identify the NTS requirements for the teams (Baker et al., 2006). Patey (2008) state that '*non-technical skills have rarely been addressed explicitly or encouraged, and as a result have been acquired unevenly'* (Patey, 2008, p41). Peterson and Perry (1999) and Perry (2004), support this assertion.

One of the main protagonists in the development of this field is Rhona Flin. She is a Professor of Industrial Psychology at Aberdeen Business School, Robert Gordon University. Flin is a prolific writer being associated to date with 12 books, 146 journal articles and 43 book chapters. Appendix A2 shows a series of key publications relevant to NTS development and Flin is cited in seven of the nine showing the influence of Flin in this field. These publications are discussed in more detail 2.5.1.

Flin was instrumental in introducing, developing and publishing articles on CRM NTS for a range of domains including aviation (2003), hospital operating theatres (2003/06), the nuclear industry (2004) and the oil industry (2005). There is a commonality of fundamental NTS across each of these HROs and high-risk environments as can be seen from appendix A2. Flin states that '…*very little training in human factors or NTS was provided to health-care staff, unlike the other safety-critical industries*' (Flin and Maran, 2015). Flin collaborated with a variety of professionals on the NTS for the various HRO and environments. These co-collaborators included Crichton, O'Connor, Martin, Goeters, Hormann, Fletcher, Glavin, Maran, Patey, Lauche, Yule, Paterson-Brown and Rowley. However, one key element of enhancement that Flin and her cohort of colleagues added was recognising the sub-skills

related to the primary NTS categories required targeting to the specifics of the relevant environment.

Each of the publications identified and cited in this section have a significant number of primary or fundamental NTS in common but the sub-skills for each of these areas is individualised to the relevant domain. This is an important point to note, that although the primary or fundamental skills are similar, it is the sub-skills that distinguish and demarcate NTS from each domain. It is relevant to consider as part of the review, the role of people and how they behave in extreme situations such as emergency response. The next section considers this aspect.

2.4 Sociology in emergency response

How people behave and act in emergencies is relevant for consideration in the review, as what people do while in an emergency response function will be affected by a range of internal and external factors. Drabek (2005) states that '*there are many definitions of sociology, most would agree that the focus of the discipline is the study of human interaction. Hence, when disaster strikes, sociologists have asked, "how do humans respond?'* (Drabek, 2005, p2). Sociologists have examined how traditional areas of inquiry, such as issues related to race, gender or social class, unfold in extreme situations. Hurricane Katrina, according to Alice Fothergill, an associate professor of Sociology at the University of Vermont (quoted by Nelson, 2011), was a turning point for disaster researchers with published research papers on the sociology of disasters or emergencies jumping from 378 in 2005 to 577 in 2006 and the number of published papers has continued to increase since this point (Nelson, 2011).

A person's effectiveness in response may be affected by the range and level of NTS that person possesses, as is the 'type' of person they are. This topic is wide ranging and multidimensional with the possibility for a whole PD to be dedicated to just one small part of the discipline. This section will examine one salient aspect of personnel profiling and whether this should be included as good practice as part of the selection process for health emergency response personnel. The review will not look to examine the culture of the

respondents but comparative questioning about gender is included in the survey and will be briefly reviewed 2.4.2.

2.4.1 Psychological profiling

It is apropos to include emergency response personnel profiling as the pre-disposition of people (Flin and Slaven, 1996) and how they may react and manage in an emergency is germane. This sort of reporting is sometimes called psychometric testing or psychological profiling and may include personality or aptitude tests. Profiling has been explored in a pre-hospital setting to establish a profile that can help identify individuals whose personalities are suited to emergency occupations (Mirhaghi et al., 2016).

Boyd and Brown (2005) note that '*All individuals differ in the way that they relate to or interpret their worlds. The way in which they innately do so, is said to reflect their individual personality*' (Boyd and Brown, 2005, p200). Some people are possibly better pre-disposed to manage when responding to an emergency. This could be due to a range of aspects including training they have received; experience from involvement in previous incidents/emergencies or a less easy to define quality of having an inherent nature or ability to cope or even thrive in these sorts of high-stress/pressure environments. A certain type of person may even seek out these situations. The NTS they possess may also affect how they react in an emergency.

Boyd and Brown (2005) conducted research using the Myers Briggs Type Indicator (MBTI)[12] for Emergency Department (ED) staff to discover if there were trends in personality types within the ED speciality. There are many types of profiling systems available but other systems will not be discussed in-depth in this review. MBTI is a widely used personality test and consists of an introspective self-report questionnaire designed to quantify non-psychopathological personality types. The responses to the questionnaire are analysed to provide an indication of differing psychological preferences defining a specific set of behavioural tendencies in attitudes, orientation, and

[12] The MBTI is a self-administered questionnaire consisting of a series of dichotomous questions. It was devised to ascertain individuals' bias in their way of expressing and relating to their environment and peers.

decision-making styles. According to Boyle (1995), an individual's personality type is described in terms of a four-letter code. The instrument is ipsatively scored, and predominantly utilises forced-choice (true/false) items. Four dichotomous dimensions classify individuals either as extraverted (E) or introverted (I), sensing (S) or intuitive (N), thinking (T) or feeling (F), and judging (J) or perceiving (P). Combinations of the four preferences determine one of 16 possible personality types. e.g. ESFJ, ENFP, INTP, and ISFJ (Boyle, 1995). There is a body of research indicating limitations with the MBTI system. Boyle (1995) suggests '*psychologists should be cautious as to its likely misuse in various organisational and occupational settings'* (Boyle, 1995, p3). However, it is still a popular personality questionnaire and Boyd and Brown considered MBTI a valid and reliable instrument (Boyd and Brown, 2005).

Using MBTI, Boyd and Brown found that within the senior ED medical staff cohort that there was a suggestion that there were notable variations from the general population in terms of their profiles. For example (Extrovert/Intuitive/Thinking/Judging) ENTJ type exhibited by 12 of the 68 ED staff (17.7%) but is only present at a rate of 3% in the general population, so it is possible that a certain sort of person seeks out/is employed in or remains within this sort of setting. Gilligan et al. (1999) recognised the requirement in surgical posts to '*discover the aptitudes and personality types of applicants for surgical posts at the outset, in order to discover which were most likely to result in a satisfactory progression through training*' (Gilligan et al., 1999, p73).

There may be a case to consider profiling personnel for the role of emergency responder as good practice, as part of the selection process for health emergency response personnel. However, there is a cost implication to this type of selection for the public sector, this is usually beyond the bounds of the budget allocated for these types of activity and could mostly be asserted that 'you get what you get' in an emergency and someone is better than no-one. This is a multifaceted area and could yield further research topics but is beyond the scope of this project but is included for context and could be considered as part of further research development.

2.4.2 Gender in emergency response

> '*There is a long history of emergency management being considered a male domain. Although the number of women involved in the process of local emergency management is increasing, there is little research on women's and men's different experiences in this environment'*.
>
> (Wilson, 1999, p111)

The topic of gender in emergency response was considered as part of the review to inform the development of the study and potential impact to NTS. Wilson (1999) noted that emergency management and response is a largely male orientated field and that not many women hold positions of leadership or authority in the profession, although this is changing. She considers this situation to be due to the roots of the profession evolving from civil defence which was predominately operated by men. Although this is a review of US emergency management, the UK also has its roots in civil defence (as per section 1.6.1) and may be analogous to the US in this aspect. Easthope (2018) observes that '*the study of gender and disasters, and also specifically research on the masculine nature of emergency planning, is under-represented in a UK specific context*' (Easthope, 2018, p242). She considers that there is much more to do to change the way in which current emergency management practices operate with regard to gender and considers contemporary practices as exclusionary. Easthope cites work by Maureen Fordham, who suggested that disasters have greater and different effects on women (Easthope, 2018, p185). Drabek also considers 'gender', a special population (Drabek, 2005).

The review considered the potential impact of gender on NTS. Huang et al. (2015) consider gender as part of a study on communication skills assessment of medical students with patients. The researchers acknowledged the small study population but considered that '*the gender of standardised patient (SP) affects the performance of medical students in communication skills assessment. In terms of checklist rating scores, the use of female SPs seems preferable to minimize potential gender effects on the performance of male versus female students*' (Huang et al., 2015, p671).

This might indicate that gender does have some influence on NTS. As with psychological profiling, this topic is multidimensional and although worthy of further research, within the parameters of a PD is beyond the scope of this research could be considered as part of future investigation.

Section 2.4 briefly considered the human factors elements of emergency response of psychological profiling and gender. The review indicates that this is an area for further exploration as to whether profiling could add some value to emergency response and to continue to explore the role of gender in this profession to negate the exclusionary nature of current practices.

2.5 Non-technical skill nomenclature

Using the correct nomenclature is important to ensure unambiguous understanding. This section examines the terminology used across a range of domains and introduces the vocabulary the research will use.

Skills are described differently in different fields. Business management commonly call the skill types, hard and soft skills (Robles, 2012). Robles defines hard skills as '*the technical expertise and knowledge needed for a job'*, and soft skills as *'interpersonal qualities, also known as people skills'* (Robles, 2012, p453). Sturgess (2012) referred to competencies and defined three types of competencies; Behavioural (or Life Skills), Functional (or Technical) competencies and professional competencies. The terms performance indicators (Hayes and Omodei, 2011) and behavioural ratings (Gaba et al., 1998) were also used. In higher education, it is recognised as human factors such as knowledge, understanding and communication skills (Easthope and Eyre, 2008).

In the context of this research, within the field of health emergency management, two main classifications of skills are the convention (Riem et al. 2012). They are technical skill (TS) and non-technical skills (NTS). Although Nestel et al., posits that '*the term NTS is misleading, inaccurate, and oversimplifies critical aspects of professional clinical practice'* (Nestel et al., 2011, p2). They contend that the terminology not the content is the issue.

They favour the term human factors as per higher education. This research will follow the convention for the field but will be cognisant of variations with healthcare.

A TS is describes by Winterton et al. (2005) as a '*functional competence*' and is the knowledge and capability to perform a specialist task within a specific field. For example, a TS could be the skill of a clinician to be able to insert an intravenous (IV) catheter. The TS may include aspects such as knowledge of human anatomy and the practical application of being able to insert a needle into a patient's arm. A person may have the TS to be a responder but may not have the corresponding NTS to support this technical ability to then be an effective responder. Flin and her co-author Maran assert that this therefore, indicates why developing NTS in individuals is so important. They state that '*poor NTS can increase the chance of error, which in turn can increase the chance of an adverse event. Good NTS (e.g., high vigilance, clear communication and team coordination) can reduce the likelihood of error and consequently of accidents*' (Flin and Maran, 2015, p28) and Shapiro et al., (2008) concur. The converse may also be inferred that good NTS will enhance technical skill performance (Riem et al., 2012). As the focus of this research is NTS, TS will not be considered further in this research.

A central tenet for this research was having a valid description of a NTS. NTS are a recognised set of skills that augment performance (Chalwin and Flabouris, 2013). For example, this could be the skill for a NHS clinician to make timely decisions or lead a team in the emergency department in an emergency response situation. A skill is an overarching term for '*the knowledge, competence and experience needed to perform a specific task or job*' (International Labor Organization, n.d., p4). Balaji and Somashekar (2009) contend that NTS encompass skills such as '*leadership, team work, conflict management, interpersonal skills, self-management, decision-making, continuous learning, empathy, persuasion, negotiation, presentation skills, personal effectiveness, diplomacy, flexibility, innovation and problem solving*'. NTS are '*the extra or additional skills required'* (Balaji and Somashekar, 2009. p50), or as an intrapersonal or social and cognitive skill (Yule et al., 2006). Peller et al. (2013) describes NTS as a combination of cognitive and social

skills, which complemented knowledge and technical skill. This is the description adopted in this research.

Having adopted a definition of NTS for the research, it was important to distinguish NTS from other skills, personal qualities or attributes. It is crucial to understand the differences and how a skill differs to an attribute or personal quality. Donahue (2012) describes skills as 'learned competencies' and attributes as more personal. She describes attributes as personal qualities encompassing values, ethics, motivation and attitude. An attribute can be described as an inherent part of someone, like being cheerful or having a sense of humour. This type of trait is not predisposed to be changed by training but accepting that training may be able to develop these attributes further, albeit with difficulty.

This section indicates that nomenclature is different in different domains, however within health emergency response, two main classifications of skills are the convention (Riem et al. 2012). They are technical skill (TS) and non-technical skills (NTS). Peller et al. (2013) description of NTS was adopted by the research. The review distinguished the difference of NTS to other skills, personal qualities and attributes.

2.6 Non-technical skill classification taxonomy

There are multiple publications that have looked at NTS classification taxonomies in different domains and occupations. The influential research of Helmreich et al., published in 1990 was the starting point (Helmreich et al. 1999). Gaba et al. (1998) examined behavioural ratings to apply in anaesthesiology based on the Line/Los checklist (LLC) from John (2008) lists 24 soft skill components for use in management. Cooper et al. (2010) cites eight medical studies using NTS in a healthcare setting. Hayes and Omodei (2011) identified 12 key competencies for incident management teams. Crisis Resource for Emergency Workers (CREW II) was a study conducted by Hicks et al. (2012) that used Human Factors Survey (HFAS) and examined team behaviours and collated a table of NTS covering seven keys areas. Chalwin and Flabouris (2013) cited 14 clinical studies that identify pertinent NTS.

2.6.1 Non-technical skill key publications

From the multiple publications with NTS taxonomies, it was important to identify key publications that were relevant to this research. Nine key publications were selected (see appendix A2). The rationale for selection was that they were directly relevant to the research either through commonality of profession (i.e. clinical/medical/healthcare setting) and/or were considered fundamental/influential NTS publications upon which later studies were based.

The nine key publications (see appendix A2) with appropriate taxonomic categories of NTS were:

1. HROs' NTS (including anaesthesiology, air traffic control and off shore oil industry) by Flin et al. (2002).
2. NOTECHS (non-technical skills), assessing pilot NTS skills by Flin et al. (2003).
3. ANTS taxonomy (anaesthetists' non-technical skills) by Fletcher (2003).
4. Nuclear response teams NTS by Crichton and Flin (2004).
5. Oil industry NTS by (Crichton et al. (2005).
6. NOTSS (Non-Technical Skills for Surgeons) by Yule et al. (2006).
7. The Ottawa global rating scale for use in critical care by Kim et al. (2006).
8. Railway Safety and Standards Board (RSSB) NTS for use across the rail industry by (Bonsall-Clarke (2008).
9. Patient safety NTS by Kodate et al. (2012).

Four of the nine publications were healthcare related or included healthcare elements but, importantly, none were specific to the classification of health emergency response skills and none had classified the sub-skills for this domain. Kodate et al. (2012) states that '*identification of the NTS required for a given job can be based on existing taxonomies for other occupations but will need to be augmented with data gathered from the relevant domain*'

(Kodate et al., 2012, p362). This was further impetus for the research to augment current data to make it relevant for health emergency response.

Given that some of the selected taxonomies were from occupations and professions beyond the emergency response domain, a rigorous review of these key publications on NTS was undertaken to assess applicability to the health emergency response context. The publications yielded an extensive list of NTS skills (53) (see appendix A3). There were duplications of skill names (21), but the descriptors (sub-skills) were different dependent on the area of work/occupation/domain. Duplicates included:

- Communication (6).
- Cooperation (3).
- Decision-making (9).
- Leadership (6).
- Problem solving (2).
- Situation awareness (8).
- Task management (2).
- Team working (5).

Multiple taxonomies of NTS were available from multiple fields and professions.

The review shows there are multiple NTS classification taxonomies in different domains and occupations. Nine key publications (see appendix A2) with appropriate taxonomic categories of NTS were selected as a basis for the study.

2.7 Measurement of non-technical skills

The literature review has considered the history, nomenclature and taxonomies of NTS, but there is another factor to consider, that of how to measure NTS. Thomas et al. (2004) states that '*despite a large amount of experience in other industries, relatively little is known about how to measure and improve teamwork in healthcare*' (Thomas et al., 2004, p57). A measure

in this context could be considered collectively as a performance measure (Savoia, et al., 2009) or as an individual NTS. For example, a measure of situation awareness (as developed for aircraft cockpit crews) could be described as '*perception of the elements in the environment within a volume of space and time, the comprehension of their meaning and the projection of their status in the near future*' (Endsley, 1988, p789). This NTS has been measured in anaesthesia (Fletcher et al., 2003) and surgery (Flin et al., 2007).

Reedy et al. (2017) notes the difficulty of assessing and measuring NTS and, as a consequence, '….*this makes it difficult to determine whether, as a result of specific simulation training interventions, individual participants have developed* (Reedy et al., 2017, p6)*'*. Kodate et al. (2012) notes that measurement is difficult because '*non-technical skills are not always directly observable and particularly in the case of cognitive skills, must be inferred from people's behaviour* (Kodate et al., 2012, p362)*'*.

Cooper et al. (2010) researched NTS in an emergency medical care setting and conducted a search of the literature to locate and review instruments to quantify NTS including: teamwork, leadership, decision-making and situation awareness. Their conclusions state that a variety of non-technical skill measures are available. However, they also note that there had only been a few assessments used in the emergency care arena (Cooper et al. 2010).

The literature suggests direct and indirect methods can be used to observe and measure NTS. Each has limitations: direct observation can change the behaviour of the observed person (Cooper et al., 2010), whereas indirect observation via self-reporting can introduce bias, especially social desirability bias. Flin noted that a crew's behaviour can be assessed through observation of CRM skills during routine simulated flights (Flin et al. 2002). There are a few disadvantages to direct observational techniques. Madge (1965) noted a distortion of behaviour due to the 'intrusive presence' of an observer/camera (Madge, 1965). This is also known as the Hawthorne effect where a change in behaviour is due to direct observation. This is challenged by Niebuhr et al., (1981) who suggests that '*most people are used to being observed in their*

day to day work, and that emergency teams are likely to be highly focused on the task and less distracted by an observer' (Niebuhr et al., 1981, p10). Understanding the challenges that measuring NTS presented informed the development of the research methodology and approach.

Chalwin and Flabouris (2013) assert that '*an important challenge will be to establish accurate and reliable measures so as to ascertain the 'value-added' impact of NTS training'* (Chalwin and Flabouris, 2013, p963). The measures that were available in the literature were the starting points for the development of a set of viable and reliable measures for this research.

2.8 Previous quantitative studies

The review of published findings revealed, a series of studies considered viable to provide context for this research. Although, no studies that specifically examined the development of NTS in HEPEs were detected there were six closely related studies that informed the development of the research method and approach (see Chapter 3). The six studies are outlined below.

- Sarpy et al. (2005) used a table-top exercise intervention with pre and post exercises measures for knowledge and skills (not specifically NTS) for public health workers (*n*=44) in response to a simulated Severe Acute Respiratory Syndrome (SARS) event. It used core competencies developed by Gebbie and Merrill (2002) via a Delphi process. Of the 12 survey items utilised on a small sample group, nine showed a statistical significant result (*p* ranged from .000 to .024) in participants' level of confidence concerning recognising and responding to a SARS event. This study stated that it was designed as a '*learning tool rather than an evaluative test'* and further mentioned that it was an evaluation of the exercise conduct not participating personnel. The pre and post measurement was of interest for this research.

- Bartley, Fisher and Stella. (2007) used a pre and post survey on hospital registrars with a small sample group (*n*=39) to assess disaster plan knowledge before and after a video (intervention) outlining the plan. They found that 7.7% passed before the video; and 89.7% passed post viewing the video ($p < 0.001$). The study was very narrowly focussed on one aspect: the disaster plan and assessing knowledge of the plan. The authors provided no validation of the survey format. The pre and post survey was of interest for this research

- Savoia et al. (2009) used pre and post evaluation to assess participants' confidence regarding legal preparedness of the public health system for infectious disease emergencies with legal professionals (*n*=56). The study used a table-top exercise as the intervention. They found that a combination of didactic teaching and experiential learning via a table-top exercise can be effective in imparting knowledge to participants with statistically significant ($p < .05$) results in all the topic areas using paired t-test. However, like Bartley et al the evaluation was used to assess knowledge not NTS. The assessing confidence and the pre and post evaluation and the use of t-tests were of interest for this research

- Fowkes et al. (2010) conducted pre and post surveys with a small sample group of health professionals (*n*=23) in a healthcare setting. They used 15 criteria to critique the emergency response plans. They found that the surveyed health professionals made changes to emergency response plans from pre to post exercise (intervention) and results were statistically significant (p=.001 to .046). The changes prompted included improvements to the activation of plans, clear roles for staff and how to coordinate the response. The pre and post survey and the healthcare setting were of interest for this research

- Kotora et al. (2014) used pre to post test scores from a disaster response exercise questionnaire for hospital staff (*n*=23) for an active shooter incident affecting the emergency department. The questionnaires were based on ten items developed from the

Department of Homeland Security IS: 907 Active Shooter course. The reported results showed a statistically significant difference of $p = 0.01$ for individuals' test scores pre to post exercise. This study used a small sample group. The pre and post scores and the manipulation of the data were of interest in this research

- Gordon et al. (2015) study was the closest in approach to this research, using NTS in a healthcare setting. The study used a healthcare setting of a hospital ward. Gordon et al., surveyed healthcare professionals (*n*=18) looking at medicines safety and observed NTS pre and post intervention. The study used a Delphi method to explore and identify learning outcomes. The survey used a Likert scale (1 – 5) that had been previously validated. This was the safety attitudes questionnaire developed by Sexton et al, 2006. The scale used was a '*six factor model of provider attitudes fit to the data at both the clinical area and respondent nested within clinical area levels. The factors were: Teamwork Climate, Safety Climate, Perceptions of Management, Job Satisfaction, Working Conditions, and Stress Recognition'* (Sexton et al., 2006, p1). They found that there was a statistically significant improvement ($p = .031$) between the mean scores for the NTS pre to post course scores for individuals. This study used an extremely small sample group. This validated scale was explored for use in this research but was focussed on 'caregiver attitudes about six patient safety-related domains' (ibid) so was not relevant for the topic under scrutiny. The pre and post intervention and the study of NTS in a healthcare setting were of interest in this research

A small sample size was a common feature across the quantitative studies. Sample sizes varied from *n*=18 to *n*=56. It is accepted that having too small a sample can prevent the findings from being extrapolated (Faber and Fonseca, 2014) and a key concern relates to the issues of (non) representativeness / bias; and low sample power increasing the probability of a type 2 error. This is due to a failure of rejecting an invalid null hypothesis.

Methodologically, the six studies were quasi-experimental, typical of simple pre-versus-post design, which provides less confidence in the findings than random control trial (RCT) evidence. However, as Harris notes, '… [quasi-experimental] *designs are frequently used when it is not logistically feasible or not ethical to conduct a randomised, controlled trial'* (Harris et al., 2004, p1586). Pre-versus-post design studies give lower confidence evidence than RCT evidence.

Overall, the research reviewed in this section of previous quantitative studies indicated a level of individual benefits; some showed an increase in scores pre to post intervention and generally there was a reported positive individual outcome. However, all the studies used a small sample size, which can reduce credibility and may be considered less definitive than RCT studies.

The chapter started with a review of simulation systems and has finished with a review of the previous relevant quantitative studies.

2.9 Chapter summary

This chapter reviewed published findings to establish the context and background for the study, and a justification for why NTS play an important role in emergency response and why it is an issue worthy of investigation.

The literature review identified the following key findings:

- A number of authors (notably Agboola et al. (2013), Savoia et al. (2009), Riley et al. (2012), Peterson and Perry (1999), Borodzicz and van Haperen (2002) and Perry, (2004)) have claimed the benefits of simulation exercises, however this benefit is not universally supported (Bartley et al., (2006) and Ford and Schmidt (2000)).

- The evidence indicates that emergency response exercises, although having limitations such as lack of realism, do provide a level of utility and Perry's 2004 statement about widespread acceptance of the claim

that emergency preparedness exercises produce a variety of benefits has support.

- The review of the utility of (health) emergency preparedness exercises and simulations concluded that there was a supportable consensus from publications that emergency preparedness exercises provide the only viable means to simulate a real event (Borodzicz and van Haperen, 2002).

- The review found that by comparing traditional emergency exercises to new technologies (such as VR), that it may be inferred that each has limitations and that the incremental additions of new technologies to the traditional systems is reducing the limitations of each with the strengths of the other, such as cost effectiveness and increased personal realism.

- There was support for the premise that training and exercising should be considered separate and distinct elements of the emergency planning cycle. Training is preparation, without which participants may feel personally under prepared and may under perform in an exercise. Exercising is validation or confirmation (testing) of the training.

- ETS, like most simulation systems has limitations but does include a key element of role play which has been shown to aid in the development of NTS (Crichton et al, 2001) in an exercise process. This would suggest that the system would be suitable as an intervention to evaluate NTS development in participants.

- The history of NTS development has its main origins in aviation in Crew Resource Management (CRM) but there was and there are key influencers in the field including Rhona Flin and Margaret Crichton.

- The pre-disposition of personnel to react and manage in an emergency response environment is germane and profiling personnel for suitability for a role in emergency response could be considered further.

- Publications cited in the review have a significant number of primary or fundamental NTS in common, but the sub-skills are specific to the relevant domain. Although the primary NTS are similar, it is the sub-skills that distinguish and demarcate NTS from each domain.

- The review enabled a valid description of a NTS to be described that would support the methodology and development of the study materials and discerned the difference between NTS and how this differed to an attribute or personal quality.

- The publications yielded an extensive list of NTS skills (53) but the descriptors (sub-skills) were different dependent on the domain of origin.

- The literature made clear that assessing and measuring NTS would be challenging due to inherent difficulties of measuring what is essentially an inference on changes in people's behaviour.

- Six previous studies were selected to provide context in the review. There were all quasi-experimental in design and had limitations of small sample size but helped inform the development of the experimental design.

The next chapter details the methodology adopted to address empirical elements of the research.

CHAPTER 3 - METHODOLOGY

3.1 Introduction

This chapter articulates the methodology used to address the aim and provides a description of the research design for the study. It provides a critical review of the approach selected and elucidates why a mixed methods study was selected. The chapter also provides a discussion of alternative methods that were considered.

3.2 Aim and objectives of the research

The aim of the research was to examine the effectiveness of contemporary health emergency preparedness exercises in enhancing the NTSs of health sector staff.

The following objectives supported the aim:

1. Establish a taxonomy of health emergency response NTSs.
2. Conduct a survey of health sector personnel to gain an insight into their experiences from participation in ETS.
3. Develop a survey-based measure of participant ratings of NTS elements of NHS HEPEs.
4. Produce recommendations on ways to enhance NTS elements of NHS HEPEs. describe and detail the NTSs that ETS participants felt were/were not developed as a product of participating in ETS.

3.3 Overview of methodological approach

> *'Paradigm issues are crucial; no inquirer ought to go about the business of inquiry without being clear about just what paradigm informs and guides his or her approach*'
>
> (Guba and Lincoln, 1994, p116)

The approach adopted made a number of philosophical assumptions**.** Associated with these assumptions are various paradigms. They vary in terms of the ontological, epistemological and methodological assumptions on which they are based. Before research is undertaken, it is important to select

a paradigm that facilitates a methodical and systematic inquiry to address the research problem. A common starting point is to consider positivism (facts and measurable), interpretivism (human experience), objectivism and constructivism. The selection of one of these paradigms would highlight suitable techniques and data collection methods consistent with that paradigm. See Vrasidas, 2001; Baronov, 2004; Quinlan, 1996; Bryman, 2012., each giving detail on the approaches with in-depth information about their core concepts and values.

3.4 The research design – why a mixed methods approach?

A mixed methods approach was selected as a combination of methods was considered to offer the potential to produce a more detailed insight than would have been possible from a traditional unidimensional (qualitative or quantitative) approach.

Discussions on the relative merits and shortcomings of qualitative, constructivist approaches and quantitative, positivist approaches can be traced back to at least the turn of the last century. Feilzer offered a way to circumvent those debates on the relative merits of various paradigms. In her paper on "Doing mixed methods research pragmatically" (Feilzer, 2010), advocated a pragmatic approach, in which quantitative and qualitative could be used in a complementary manner, with choices over method reflecting the best fit with the phenomena of interest. In a similar vein, Tashakkori and Creswell (2007) note that combine methods require *'… the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry*' (Tashakkori and Creswell, 2007, p4).

Hanson (2008) argues that the most important question was whether the research had helped to find-out what the researcher wanted to know. Feilzer contended, that '*pragmatists do not ''care'' which methods they use as long as the methods chosen have the potential of answering what it is one wants to know*' (Feilzer, 2010, p9). This is supported by Johnson and Onwuegbuzie (2004) who stated that '*the goal of mixed methods research is not to replace*

either of these approaches but rather to draw from the strengths and minimise the weaknesses of both' (Johnson and Onwuegbuzie, 2004, p15).

O'Cathain et al. (2007) undertook a survey of the use of mixed methods in Health Services Research (HSR). In their review, they found that the reasons for using mixed methods usually related to a pragmatic need and that '*researchers justified the use of a mixed methods approach on pragmatic rather than ideological grounds*' as they '*worked in an applied field studying complex issues*' (O'Cathain et al., 2007, p8). Feilzer (2010) states that '*the choice of social sciences research questions and methods, albeit sometimes dictated by research funders, is a reflection of researchers' epistemological understanding of the world'* (Feilzer, 2010, p2). In this study into emergency response and preparedness, which is a pragmatic environment, looking for practical approaches to the issues that effective emergency response requires, it was necessary to take a pragmatic approach. This was to enable the balance of the requirements of academic rigour with the practical difficulties of interacting with busy NHS personnel, for whom research is not a high priority.

Having selected a mixed methods approach for the research reported in this thesis, it was then important to consider the various options of mixed methods design (Wisdom and Creswell, 2013). Wisdom and Creswell consider various options for the design. They were convergent, explanatory sequential, multi-phase and embedded designs. Having considered the relative merits of each, an explanatory sequential design was selected, as this would provide the chosen outcome. This would be achieved by firstly collecting the qualitative exploratory data. Once analysed, this data is used to develop a psychometric instrument that is applied to the study sample. This instrument is then, in turn, administered to a sample of a population. This was very closely aligned with the agreed design of the study and was adopted for use in the study.

3.5 Overview of the data collection methods

Using the literature review to inform the research design the main methods to collect primary data relevant to a mixed methods approach were reviewed,

assessed and related to how relevant previous studies had collected data. The six quasi-experimental studies reviewed in section 2.7, all used pre and post surveys and had small sample sizes (n=18 to n=56). They used surveys as the principal data collection method with five using a survey with a table-top exercise as the intervention and one using a survey with a video as the intervention.

The main methods to collect primary data relevant to a mixed methods approach will now be discussed to consider the relative strengths and limitations of each to inform the data collections methods to be utilised in the thesis.

The data collections methods considered are shown below and are consistent with a mixed methods approach (Tashakkori and Teddlie, 2003). A key principle that was applied was ensuring that the methods selected, when combined, that each has different limitations/weaknesses.

The data collections methods considered were:

1) Secondary data
2) Tests
3) Interviews
4) Observation
5) Focus Groups
6) Questionnaires

1) Secondary data

Secondary data is available from a range of sources. As the data/information has already been collected it is time-saving and can be cost-efficient. It can be useful for exploration and is unobtrusive and can make data analysis easier. However, data may be incomplete and is selective. Further, some content may be difficult to access. It may also not be applicable to the population under consideration. There is also the possibility that as the data may have been used before that most of the key findings have already been

'mined'. This was considered unfeasible as a data collection method due to the lack of population specific data that could be sourced and used.

2) Tests

Common types of test include intelligence, personality and aptitude tests. This type of data collection may provide 'hard' quantitative data which may be easy to analyse and can provide common measures across a population. However, tests can be expensive to administer (if the test needs to be purchased) and can be biased to certain groups of people and may not apply to the population being studied. There is also the potential for nonresponse error. Although this method would provide the quantitative data sought for stage two, the types of test available was not considered appropriate to achieve the study aim.

3) Interviews

Interviews can be structured or semi-structured or completely unstructured. There may be a questionnaire associated with the interview which may range from spontaneous questions to exacting scripts which the interview reads verbatim and records the answer. Interviews allow for the interviewer to probe for more detail than mail or online questionnaire would allow. However, interviews can be time-consuming (due to setting up, interviewing, transcribing, analysing, and reporting), this can also make them expensive. There may be a need to travel to the interviewee, this has cost and time implications for the interviewer. Also, there is a need for continuity of interviewer as different interviewers may understand and transcribe interviews in different ways. This method while having the positive of allowing the probing of interviewee for more insight with qualitative data was considered impractical due to the travel and cost implications of travelling to multiple ETS events which were geographically spread and would not have provided the quantitative nature of the data consider important for stage two of the study.

4) Observation

An observation is way of gathering data by watching the behaviour or noting physical characteristics in a natural setting. An important consideration for this data collection method is the impact on the persons being observed and how

this might change in the presence of the researcher. The observations can take the form of exploratory open-ended observation with the researcher taking fieldnotes and possibly recording (audio or video) the occurrence being studied. The researcher can also become a member of the group in a 'observer as participant' role or can be an outside observer. Observation can result in more natural behaviour occurring but possibly only if people are unaware of being observed. In this case, behaviour may be affected. Data collected from observations may be time consuming to analyse and require training to ensure effective data capture. Sometimes there is a need for more than one observer. The observation event can be difficult to replicate as it may not be possible to control extraneous variables. Observation was considered as a method, but the nature and focus of the research and the time constraints discounted this as a viable option. This may be an option for future study to allow a more in-depth view of the behaviours of persons in a health emergency response environment. Kodate et al. (2012) note that NTS measurement is difficult because '*non-technical skills are not always directly observable and particularly in the case of cognitive skills, must be inferred from people's behaviour*'.

5) Focus Groups

Focus groups can be useful for exploring ideas and gaining an in-depth understanding of people's opinions on a topic. A key advantage is the quick turnaround of the data and allowing participants to interact and react to each other. There can be a cost implication involved in bringing a group together and there can be an impact on a participant if they feel under scrutiny. It is however, difficult to generalise small unrepresentative samples that are the core of focus groups. Considering the merits and limitations of this method it was considered suitable for stage one of the study. The limitations could be addressed as the cost of convening an appropriate focus group would be borne by PHE and although the group would be small, the data would be correlated with key publications to ensure consistency.

6) Questionnaires

There is a difference between a questionnaire and a survey. A survey is an evaluation of opinions (or experiences) of a group of people via questions as

opposed to a questionnaire which, is a collection of questions with an answer choice and is created to conduct a survey. A survey uses a questionnaire to gather data from a set of respondents.

The advantages of questionnaire are that a large amount of information can be collected from a sizeable number of people over a short period of time and can be relatively cost-effective. Unlike observation, a questionnaire can be deployed by any number of people with limited effect on the validity and reliability of the questionnaire. The output of the questionnaires may be assimilated and easily quantified using a software package such as SPSS. This analysis can be more objective than other methods and can be used to compare and contrast the results or to measure change. However, questionnaires can, it could be argued, provide an inadequate understanding of some forms of information such as emotions or behaviour. Also, there is no way to determine the honesty of respondent's responses or how much consideration a respondent has put in to the answer to a question. Questionnaires can suffer with ambiguity of questions as different people may read and interpret questions differently. This can be addressed to a certain extent by effective piloting. Considering the argument above, it was felt that a questionnaire as part of a survey would provide an appropriate data collection method for stage two.

Having considered the literature, the research data collection methods selected were:

a) A focus group in the form of a Nominal Group Technique. This NGT would be formed with experts in the field of EPRR and ETS specialists (qualitative).
b) A survey in the form of an online pre and post intervention questionnaire (quantitative).

These data collection methods would enable the researcher to carry out a detailed investigation of the study area than would be gained using just one method of data collection and each had complementary strengths and weaknesses. This is consistent with literature from previous studies (as

discussed in section 2.7) which were quasi-experimental and all included pre and post surveys.

The rationale for the methods selected are described in greater depth in chapter's four and five. To provide an overview justification of the data collection methods selected: A focus group in the form of a NGT was selected because it had distinct advantages over the other key group method considered (Delphi consensus method), as it would provide a structured way of producing a viable, informed list of health emergency response NTS and was expeditious. Delphi technique can be slower than NGT and would not produce the NTS list in a readily available and useable format. A NGT afforded a structured way of producing a qualitative prototype taxonomy of health emergency response NTS and additionally provided a means by which to maintain participant focus. The NTS chosen would focus on those primary NTS most pertinent to health emergency response. This focus on primary NTS was crucial, as a limitation of the pre and post intervention questionnaire was that ETS participants could not be surveyed on all the NTS that could potentially be developed during a HEPE. Based on the literature review, this could theoretically be circa 30 to 40 NTS. The respondent burden would then have been excessive (Ben-Nun, 2011). A method to target primary health emergency response NTS for use in the survey with ETS participants was essential and NGT would provide this targeting.

A survey was selected for stage two over the other main method considered (interviews – face-to-face and telephone), as it would allow an insight into participant experiences and produce quantitative data that could readily be analysed. Interviews were impractical due to the wide geographic distribution of the ETS delivery locations and the number of interviews that would be required. The survey was considered a cost effective and efficient way of capturing geographically distant participants and would allow a sufficient range of responses.

Figure 2 shows how the data collection methods selected were linked; that each stage embodied plural elements; and each phase was iteratively reviewed to ascertain that it remained appropriate and justified. The process

consisted of data collection followed by analysis as per the explanatory sequential design outlined in section 3.4. The sequence was planned from the outset; however, it was re-evaluated at each stage to ensure that the initial assumptions remained valid and worth pursuing; that the current course was still appropriate and that novel or different routes had not been overlooked. There were changes in the process which are identified in the next two chapters which arose from the outcomes of the pilot studies of both the focus group (NGT) and the survey.

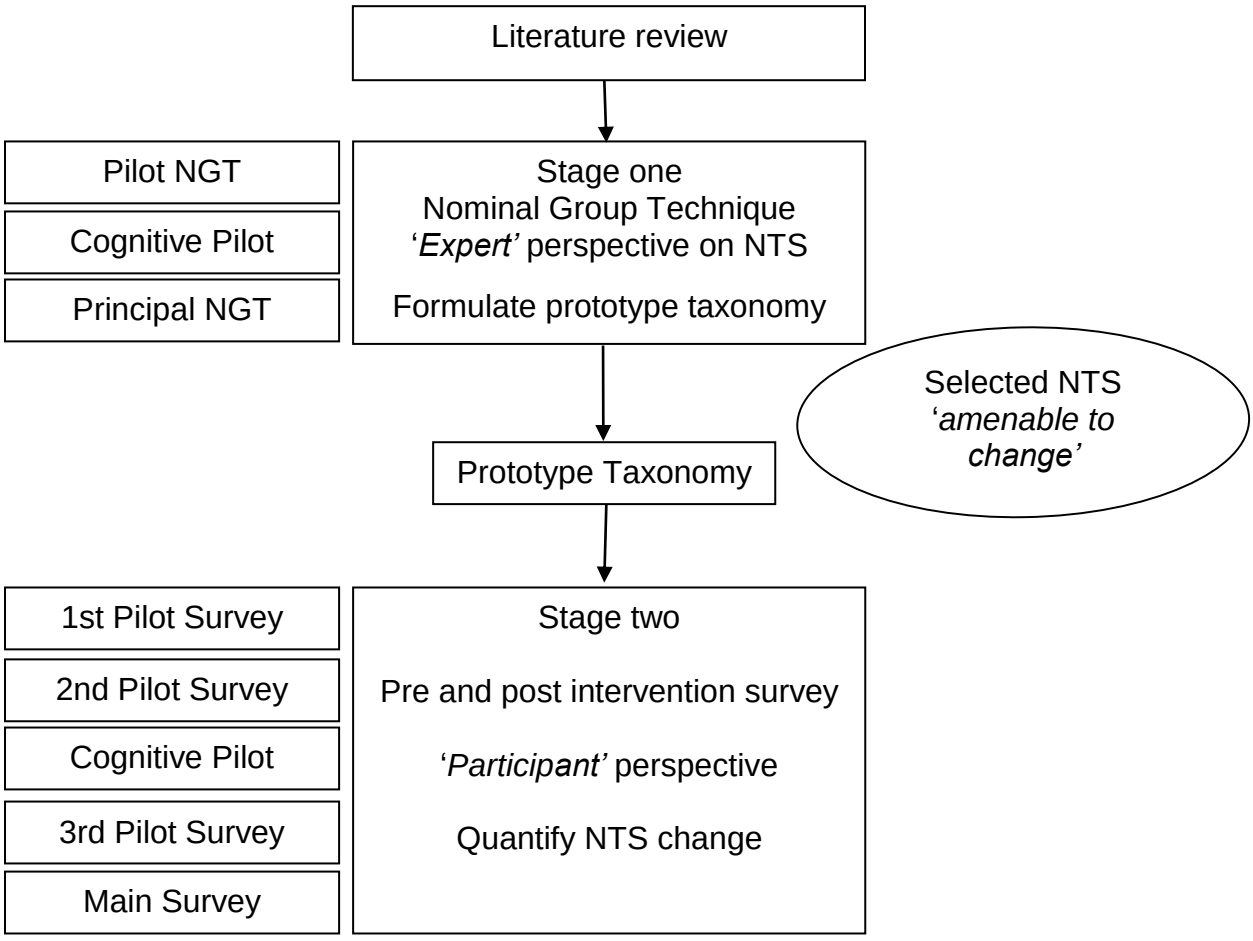

Figure 2. Progression of research methods

The research used ETS as the intervention to obtain participant perspective on skill development. ETS is an interactive simulation platform used to replicate emergencies in a healthcare setting such as a hospital Accident & Emergency department. It is recognised by the NHS as a model for contemporary HEPE. This simulation system is discussed in section 2.2.3.

In addition to the data collection method, a sampling method was selected to offer the potential of being representative of the target population.

3.5.1 Sampling

Sampling is the selection of a subset (a statistical sample) of individuals from within a statistical population to estimate characteristics of the whole population. It is important to explore the options available and consider the relative merits of the various methods and techniques available. One important aspect about any type of sampling selection is how representative of the population the results will be. One of the problems that can occur when selecting a sample from a target population is sampling bias. Sampling bias refers to situations where the sample does not reflect the characteristics of the target population. It is not generally possible to sample everyone in the target population so a technique to choose people who are representative (typical) of the population as a whole is the norm. The target population in this research will be a subset of NHS personnel across all NHS trusts in England. The subset will be people who could potentially attend an ETS event. This is very large target population and due to the potentiality of attendance, indeterminate to the researcher. Further, a necessity to ask people to volunteer for a study will create a sample that is not random as some people may be more or less likely to volunteer for these types of activity. This may make it more appropriate to consider a non-probability sample.

Buckingham and Saunders (2004) asked if the selected sampling techniques gives a group of respondents whose answers represent the whole population from whom they are drawn (Buckingham and Saunders, 2004). The more representative the sample, the more confident the researcher can be that the results can be generalized to the target population. However, the challenge is selecting a sufficiently representative sample within the constraints of the research in terms of time, budget and availability/access to participants. This is where a trade-off may occur to be sufficiently expeditious while retaining sufficient integrity of the sampling process. Mitigation for any limitation in sampling robustness is offered by Stallings (1997) who observes that the

context of disaster research, by being in a different setting to more traditional social research makes the research unique and time constrained. Further, Drabek (cited by Stallings) used many different methods and advocated letting the research problem determine the method rather than the other way around.

A key principle that was applied was ensuring that the sampling method selected considered the constraints imposed by the research in terms of time, budget and availability. Various techniques were considered and each had different limitations and strengths.

There are various methods available to sample a target population. The sampling techniques considered were:

1) Random
2) Stratified
3) Quota
4) Self-selected
5) Convenience

Each will now be explored to consider the relative merits of each.

1) Random sampling

This sampling technique is defined as a sample in which every member of the population has an equal chance of being chosen. This involves identifying all members of the target population and then selecting the number of participants required in a way that gives everyone in the population an equal chance of being picked. Random sampling is considered the foremost technique for providing an unbiased representative sample of a target population. However, random sampling can be time consuming and can be unrealistic to achieve if there is a large target population. Further if, to access your population, you need to request volunteers for a study, the sample is no longer random. Although random sampling is considered the 'best' option in terms of selecting an unbiased sample, the target population for this research is large and geographically widely spread and to identifying the target

population and to access the participants would be beyond the time constraints of the research. A request for NHS staff to volunteer will be required, negating the random nature of this technique. This method would not be the most appropriate to provide the required sample. A stratified sample can also provide a representative sample.

2) Stratified sampling

To conduct a stratified sample, the target population is classified into categories and then a sample is chosen which consists of participants from each category in the same proportions as they exist in the population. This selection process can provide a representative sample of the population. As with random sampling, stratified sampling can be time consuming as the categories of the target population have to be identified and calculated. This can be problematic, if the details of all the people in your target population are unknown. Based on similar reasons as for random sampling, that although this technique may provide an unbiased sample, the target population for the research is large and would take excessive time and cost to achieve a viable classification of the entire target population. For this reason, this method was not considered further as it would not provide the sample required. If the sample is not randomly selected from the categories, it is then called a quota sample.

3) Quota sampling

Quota sampling is not a common method used in social research but is used extensively in commercial research like political opinion polling. The sampling relies on producing a sample that is representative of a population in terms of categories such as gender, ethnicity, age, social economic groupings and region of residence. A set number of people within each category is decided upon and these quotas are ‘filled’. An interviewer will seek out individuals that fit several sub groups. This is a limitation of the method, the interviewer decides, reducing the random nature of the selection. Further, the quota may reflect superficial characteristics in the population and interviewees may be those who were friendly enough to approach or in the interviewer’s vicinity at the time of the survey. It can be cost effective and short travel times between interviewees and the interviewer does not need to follow up and call back as

the interview is conduct at the time. This also makes it a rapid method to collect data, however Bryman (2012) suggests that people in lower social strata are under-represented. This approach was considered incompatible with the research because although the time to complete the survey would have been expeditious, access to participants who were geographically spread before and after the intervention would not be cost effective in terms of time or budget.

4) Self-selected sampling

Self-selected sampling (also called volunteer sampling) consists of participants becoming part of a study because they volunteer when asked or in response to an advert. This sampling like convenience (opportunity) sampling is quick and relatively easy to achieve and can reach a wide variety of participants. However, as noted in the random sampling, the type of participants who volunteer may not be representative of the target population as they may be more obedient or more motivated to take part in studies. The research suggested that this might be a viable technique, as volunteers will be required however the participants need to be available and accessible and have sufficient time to complete the surveys. A convenience might be more appropriate for the target population.

5) Convenience sampling

Convenience sampling (also called opportunity sampling) is a popular sampling technique and involves taking a sample from people who are available when the study is being conducted and fit the selection criteria. It is commonly used as a sampling technique as it is convenient in terms of time and budget. There is a downside to this sampling, Bryman cites the limitations of this type of opportunity sample as problematic in terms of generalising the findings '*we do not know of what population this sample is representative*' (Bryman, 2012, p201). This technique can also produce a biased sample, as it is easy for the researcher to choose people from their own social and cultural group creating a sample that is not be representative of the target population. A further limitation is that participants may decline to take part and your sampling technique may turn into a self-selected sample. Considering the merits and limitations of this techniques, it was selected as

the most viable option as although not ideal would be acceptable as the NHS staff could be difficult to access and accepting that some would not be able to complete the pre and post surveys possibly leading to inclusion of self-select elements in the sample. Bryman (2012) states that convenience sampling although problematic in terms of generalisation to the wider population represents an opportunity to gather data and provide a spring board to further research and that this type of sampling is frequently used in social research because of its strengths of time and budget and accessing members of the target population.

A series of sampling techniques were explored and assessed in this section and based on the relative merits and limitations of each, convenience sampling was selected as the method offered the most suitable technique within the time, budget and availability/access to participants available. The sampling technique selected is described in greater depth in chapter five (section. 5.5.1).

3.6 Chapter summary

This chapter articulated the methodological perspective and the methods design selected to achieve the research aim. It provided the rationale for why a mixed methods approach was considered suitable for this study. Further, it provided various options for the methods design within the mixed methods research design. The chapter included an overview of the iterative design of the multi-stage study through multiple pilots and revisions to the data collection using the mixed methods approach and the reasons for the selection of the chosen data collection methods and the sampling technique adopted.

The methodology chapter identified the following key findings:

- A range of paradigms and perspectives were considered for the study. However, the literature suggested a mixed methods (qualitative and quantitative) approach may be the most appropriate.

- Having selected a mixed methods approach, the literature indicated that the adoption of a pragmatic perspective would enable both quantitative and qualitative methods to be used to offering the best fit to study the phenomena.

- Various mixed methods approaches were considered from convergent to multi-phases to an embedded design, however, an explanatory sequential design that would support the development of a survey instrument was considered the most appropriate.

- Using a mixed method approach, an array of data collection methods were considered. After consideration of the evidence on their relative strengths and weaknesses, focus groups and questionnaires were chosen as complementary primary data collections methods.

- Various sampling techniques were assessed based on merits and limitations and convenience sampling was selected as the most appropriate technique.

- The focus group and survey rationale were outlined using a NGT for the focus group and this would be followed by an online survey using a questionnaire. Each stage would be supported by a series of piloting phases to inform the final iterations of the NGT and survey.

Chapters four and five provide a more detailed justification and explanation of the mixed method approach employed in the research and discusses the data in terms of answering the main research questions and the significance that can be inferred from the data.

CHAPTER 4 – EXPLORATION OF EXPERT PERSPECTIVES ON CORE EMERGENCY RESPONSE NTS

4.1 Introduction

This chapter articulates the method used in stage one of the study. It provides a critical review of the data collection method selected and explains why this constituted the preferred approach. It considers the relative merits and relative to alternatives. The chapter describes how difficulties and problems were overcome and includes a chronology of this stage (stage 1).

4.2 Context and purpose

The research aim was supported by four objectives (see 3.2). Objective one was: To establish a taxonomy of health emergency response non-technical skills. An expert group in the form of NGT was considered the most appropriate means to address this objective and gain the required understanding; the underpinning rationale for this is explained in Chapter 3.

The purpose of the NGT was to use the experience of the panel of healthcare emergency responders and members of the UK faculty for ETS experts to explore and identify NTS relevant to health emergency response. This stage was looking for an insight from the experts to inform the development of a health emergency response NTS taxonomy. It was considered that the NGT would contribute to answering the research question by providing the right forum and conditions to explore these core NTS in emergency response to create a prototype classification of the relevant NTS.

To allow for parallel activity in the research, some stage one and stage two phases were conducted concurrently. Stage two was the evaluation of participant perspectives, which is detailed in Chapter 5. Figure 3 shows the chronology of stage one and the overlap with stage two activity.

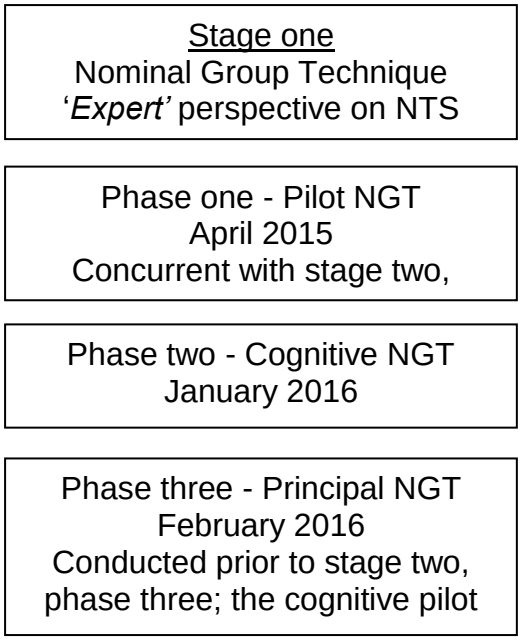

Figure 3. Chronology of stage one

4.3 Method

Stage one was looking for insight from a group of selected of expert's perspectives and that could be conducted with the preferred expert members within the timeframe and resources available. Stage one was closely aligned to stage two. Stage two would explore participant perspectives on NTS development and benefit from a targeted NTS list that could be used in this stage. An assessment of various methods was conducted.

A questionnaire at this stage would not have allowed for the in-depth discussion and face-to-face interaction of experts about the relevant skills in health emergency response. It would also not have allowed follow up questions to be asked of the experts to clarify answers, and the data would have required a lengthy collation period.

Similar issues would have been exacerbated by one-to-one interviewing. A Delphi focus group was considered as the research planned to use a target population of experts (Keeney et al., 2001) but would not have provided the degree of control of the group as a method such as an NGT. Delphi groups are less structured than NGT group interactions which are very prescribed. Delphi is often conducted over a period of time. McMillan et al. (2016) notes

that the Delphi technique can take weeks or months to conclude, especially if there are several rounds required. Participating experts may only be available for a limited period and the resources available to assemble them may also be limited. Further, the output from Delphi would have been less organised and planned than an NGT output which is highly structured. Due to these reasons, the Delphi method was considered incompatible with the stage one aim.

Semi structured interviews were considered as this would have allowed for opinion to be collected, however the data would not have been in a readily useable form and would have taken considerable time to compile and analyse. In addition, the experts that would have been required were widely dispersed geographically so would have been time consuming to visit. Telephone interviews could have been used but again the data would not have been in a readily useable form.

A NGT is a consensus group method. A NGT would make it possible to assemble the required experts together for a face-to-face meeting and would be more expeditious than the generally lengthier Delphi process, which can take a substantial period to complete. The NGT method has the additional benefit of maintaining group focus. McMillan et al. (2016) notes that NGTs are useful to explore stakeholder views and that Delphi groups are more commonly used for developing setting priorities, routinely where there is limited consensus. Denscombe notes that NGT are '*often used in small scale research and lends itself to qualitative data collection and can be used as a way of probing relatively unexplored topics and as a route to the discovery of new ideas or theories'. The point of the sample is to provide the researcher with a means for generating insights and information*' (Denscombe, 2014, p33).

A significant advantage of an NGT is that by the nature of the group conduct, a list of targeted outputs in the form of a viable, informed list of health emergency response NTS could be produced. This would be in a readily available and useable taxonomy that could be utilised in stage two. This output was favourably aligned to the aim and requirements of this stage of the

research and made NGT a better choice than Delphi. Given all the benefits a NGT could provide, it was selected as the most appropriate data collection method for stage one.

4.3.1 Development of a targeted NGT process

> *'The nominal group technique combines quantitative and qualitative data collection in a group setting and avoids problems of group dynamics associated with other group methods such as brainstorming, Delphi and focus groups. Idea generation and problem solving are combined in a structured group process, which encourages and enhances the participation of group members.'*
>
> (Gallagher et al., 1993, p76)

Having selected NGT as the method, it was necessary to pilot the NGT approach to ensure the process and outputs were as expected. One negative of any group interaction is that there can be conflict or disagreement. This type of forum can be dominated by strong personalities and therefore requires effective management and positive direction of participation in the discussion (McNeill and Chapman, 2005). However, a strong chair can alleviate this possibility. Neither the pilot nor the principal NGT was dominated by one person; the researcher was the chair and had extensive experience and training in these situations and was able to provide effective discussion control. This experience is detailed in the introduction and section 4.4 conducts an ethical exposition of the researcher in this role and the implications of bringing the research into the practice environment.

A pilot expert panel of professionals was convened drawn from healthcare emergency response; including Accident & Emergency departments, hospital emergency planning officers (HEPOs), emergency management plus members of the UK faculty for ETS who were either Senior Instructors or Educators (the definitions are in section 2.2.3). Some of the selected experts had experience across more than one area of interest, that being ETS and emergency preparedness. These experts had insights into ETS and the skills

required in a health emergency response. The pilot NGT had six members and convened on 22 April 2015 at PHE Porton, Wiltshire.

The pilot NGT data collection was approximately two hours long and was run in accordance with a detailed ten step schedule (appendix B1) developed from Wainwright et al. (2013). The pilot participants were invited and provided with clear instructions on how the process would be conducted and what their role would be. No other information was provided.

The pilot group was tasked to recall their experience in a challenging emergency response situation or during an ETS delivery using cognitive task analysis (CTA) (Seamster et al. 1997). CTA is described as a strategy to *'capture a description of the knowledge that experts use to perform complex tasks*' (Clark et al., 2006, p1). The group were asked to describe the NTS required in the resolution/management of the situation. This was to garner pertinent NTS for health emergency response. This enquiry was supported by two questions which focused the discussions on the task of the group.

Two key NGT questions

1. What are the NTS that individuals require to respond in an emergency situation?
2. Recall and describe your experience in a critical incident or during an ETS delivery and list the NTS you believe were important in the resolution/management of the situation or incident.

Separate health emergency response NTS (38) were identified by the group, using the NGT process, this was reduced to eleven NTS. These eleven NTS were also used in phase one of stage two.

The pilot NGT (phase one) was used to refine the NGT process including the questions and to ensure that the NGT provided the expected outcome. This pilot NGT identified two clear areas for development.

1. Some NTS identified by respondents did not conform to the research definition of NTS, they were personal qualities or attributes, for example, one '*skill'* suggested was to be calm (*under pressure*). This, according to the literature review, may be considered a personal quality or attribute. Although training may develop this attribute, it would be beyond the scope and resource of a HEPE. This misunderstanding was due to the absence of a clear definition of the NTS for participants. To address this omission, phase two and three - the cognitive and principal NGT had a clear description of a NTS[13] and how this differed from a personal quality or attribute[14].

2. The second area identified as sub-optimal was the absence of representative NTS (including a description of the NTS) for the group to select from. The pilot NGT participants were requested to consider the NTS required to address the two NGT questions and were not constrained by any intervention from the NGT chair. As a result, some of the definitions were ambiguous, colloquial and lacked academic rigour. Neither did they reflect close alignment with previous studies/publications definitions or ensure that all relevant NTS were explored. To address this, in the cognitive and principal NGT, participants were provided with a list of NTS obtained from a rigorous review of key publications on NTS, as detailed in 2.5.1.

These two adaptations were made for the conduct of the cognitive and principal NGT (phases two and three). The cognitive and principal NGT members were provided with a clear definition of a NTS and an attribute in the context of this research.

The literature review identified key NTS publications (appendix A2); phase two and three NGT participants were provided with a list of 53 candidate NTS from these key publications (see appendix A3). All relevant publications from the literature review were assessed using the criteria below. NTS taxonomies

[13] Peller et al., 2013 - A combination of cognitive and social skills, which complement knowledge and technical skills and contribute to safe performance (Peller et al., 2013, p395)

[14] An inherent part of someone, like being cheerful or having a sense of humour

were included if the publication met the obligatory element and observed at least one other criterion.

- Obligatory - Provided a validated list of NTS with sub-skill descriptors.
- Recognised authority on NTS research – i.e. multiple publications and citations.
- Provided a validated list of NTS with sub-skill descriptors associated with health-related professions.
- Demonstrated the development of NTS and built upon previous research.
- Avoided high degrees of duplication.

Nine papers were selected; the publications ranged from 2002 to 2012 and demonstrated the development of NTS research over this period.

The nine papers provided 20 skill names. There were duplications, for example there were six ‘communication skills’ and eight ‘decision-making skills’ included but only one ‘conscientiousness’, resulting in 53 NTS. However, the descriptors were different dependent on the area of work/profession/domain it was targeted at. For example, Flin et al. (2002) publication focussed on teams in high reliability industries (e.g. nuclear or aviation) and subcategorised the communication skill as having the following elements; assertiveness/speaking up; asking question; listening; giving appropriate feedback; and attending to non-verbal signals (as per Figure 4). In contrast, Kodate et al. (2012) paper on enhancing patient safety subcategorised the communication skill as giving information clearly and concisely including context and intent, receiving information and identifying and tackling barriers to communication. Although both were related by the name communication, the sub-skill descriptions were different dependent on context.

4.3.2 Adaptation of the NGT process

To ensure the usability and applicability of the 53 NTS in phase three; the principal NGT, five personnel (with expertise in health emergency response)

from the Emergency Response Department (ERD) at PHE Porton were asked to participate in a cognitive NGT of the selected NTS to provide a 'sense-check' of the NTS. Each of the 53 NTS were alphabetised and allocated a number between one and 53, then reproduced on a card which contained the NTS plus the descriptor for that NTS, as per the illustration in Figure 4.

No.	Skill Name	Skill description
3	Communication	Assertiveness/speaking up Asking questions Listening Giving appropriate feedback Attending to non-verbal signals

Figure 4. Skill card for one of the 53 candidate NTS

Each of the five participant experts was tasked, individually, to select ten NTS that addressed the two NGT questions from the 53 NTS available, then to rank them from one to ten. The questions were: What are the NTS that individuals require to respond in an emergency situation? and to recall and describe an experience in a critical incident or during an ETS delivery and list the NTS important in the resolution/management of the situation or incident.

This was to mirror the NGT process (see appendix B1). 45 of the possible 53 NTS were selected during the cognitive pilot and gave a positive indication that the NTS list was representative and could reasonably be used in the principal NGT due the high proportion of NTS selected. Once the NTS had been validated, the principal NGT was convened.

4.4 NGT ethics

The researcher approached potential participants based on experience, suitability and availability for the NGT date and location. The target population for the NGT were healthcare emergency responders and members of the UK faculty for ETS. Participants were informed that participation was voluntary, and they were free to withdraw from the study at any point without giving any reason. They were assured of anonymity and that their contribution would be reported using a non-attributable form (a copy of the University of Bath, Department for Health Research Ethics Approval for this study is provided at

appendix B2). The participants were provided with an information sheet about the research (see appendix B3) and were asked to sign a consent form (see appendix B4).

4.4.1 Bringing research into the practice environment

> *'It is crucial for social researchers to clarify their researchers' roles, especially for those utilizing qualitative methodology to make their research credible.'*
>
> (Unluer, 2012, p1)

At this point, it is appropriate to conduct a discussion on the practice and ethics of a researcher bringing research into their own practice area; to be the 'insider' researcher and the potential for bias that this may produce. There have been many advantages of being an insider-researcher mooted. Bonner and Tolhurst (2002) outline three key advantages of being an insider to the research domain. They consider these to be a) a superior understanding of the group's culture, b) the ability to interact naturally with the group and its members; and c) a previously established, and therefore greater, relational intimacy with the group (Bonner and Tolhurst, 2002). Other reasons include; '*speaking the same insider language, understanding the local values, knowledge and taboos, knowing the formal and informal power structure, and obtaining permission to conduct the research, to interview, and to get access to records, and documents easily facilitate the research process*' (Unluer, 2012, p5).

These advantages are balanced against a range of limitations of being an 'insider' researcher. The researcher may create a role duality of instructor and well as researcher; may overlook certain routine behaviours; may make assumptions about the meanings of actions and not seek clarification for the actions; may assume he/she knows/understands participants' viewpoints and issues. There is potential for the participants to assume the researcher already knows what they know and the insider's closeness to the situation may hinder them from seeing the bigger picture when collecting the data. See

Herrmann, 1989; Rooney, 2005; Sikes and Potts, 2008; Smyth and Holian, 2008. These limitations may create bias in the research.

Chavez (2008) states that there are '*differences between types of bias associated with either being an insider or an outsider. For an outsider, the danger is the imposition of the researcher's values, beliefs, and perceptions on the lives of participants, which may result in a positivistic representation and interpretation. For an insider bias may be overly positive or negligent if the knowledge, culture, and experience she/he shares with participants manifests as a rose-colored observational lens or blindness to the ordinary*' (Chavez, 2008, p475). Breen (2007) considers that '*the insider/outsider dichotomy is simplistic, and the distinction is unlikely to adequately capture the role of all researchers. Instead, the role of the researcher is better conceptualised on a continuum, rather than as an either/or dichotomy'* (Breen, 2007, p163). She considered that she was neither an insider-researcher nor outsider-researcher which enabled her to maximise the advantages of each while minimising the potential for disadvantages. Easthope (2018) notes that '*The uniqueness of my own role as a participant and an observer and the uniqueness of the study setting have shaped a 'negotiated inquiry' that is situated, particular and individual*' (Easthope, 2018, p19). She reflects that her role as senior government adviser in emergency planning and an emergency planning lecturer 'entangled' her research and practice areas. However, she considers that this allowed for a unique insight that may not have been afforded to an 'outsider'. This aspiration to afford a unique insight is continued in the research.

Considering the reflection in this section. It may be inferred that while there is the possibility of bias from being an 'insider', the advantages can be maximised and disadvantages minimised as per Breen (2007), to reduce any potential bias and exploit insider knowledge while being cognisant of its limitations, in line with Brannick and Coghlan (2007) who conclude that '*within each of the main streams of research, there is no inherent reason why being native is an issue and that the value of insider research is worth reaffirming'* (Brannick and Coghlan, 2007, p74).

4.5 Data collection and analysis

The principal NGT was convened on 5 February 2016 at PHE Porton, Wiltshire. The group had five members. Seven were invited but due to a late cancellation by one participant and the unavailability of a second, only five were present. The principal NGT was run according to appendix B1, the ten step NGT plan with the changes identified in 4.3.1. The members were welcomed and briefed (step one).

Step two was then conducted, selecting relevant NTS from the 53 NTS available (appendix A3). The panel members selected 35 NTS from the possible 53.

These 35 NTS were discussed in step three to study each skill in turn and consider if the sub-skill descriptor was appropriate for health emergency response. The 53 NTS came from a range of professions. For stage two, NTS relevant to health emergency response would be required and participants were encouraged to amend/suggest inclusions to make the NTS (in particular, the sub-skill descriptors) bespoke to health emergency response.

In step four, the expert panel agreed the NTS and sub-skill descriptors associated with each.

In step five, each participant selected ten of the 35 NTS to rank. A NTS ranked one was given a score of ten; ranked two, a score of nine and so on to ten having a score of one. The scores are shown in appendix B5. The intended output at step five was ten NTS in score order but as appendix B5 shows five NTS had the same score of eight and were all ranked ninth. This meant that 13 NTS were carried forward to step six.

In step six, the NTS scores were calculated and entered on a spreadsheet to present back to the NGT group. Concurrently, the group completed step seven (a timeout).

The 13 NTS (in rank order) were discussed in step eight to debate the ranking and to decide if there were any obvious omissions. There was a possibility that relevant health emergency response NTS were omitted and therefore not included in the debate. This possibility was reduced to a minimum by the rigorous literature review of NTS. No omissions were identified.

In step nine, the 13 NTS were re-ranked by participants and assigned a weighting between one and 100. Rank one was assigned a value of 100 and rank five assigned a value of one. For ranks two, three and four, panel members were able to assign any value between 99 and two. These scores were entered on a spreadsheet (see appendix B5). The NTS were then re-ordered according to the weighting assigned. This produced 13 re-ranked NTS.

Before the NGT concluded, a further question was posed. The question asked was if the NTS 'top 10' list would be different for three types of real incident from the one produced in the principal NGT. These incidents were a mass casualty train crash, a pandemic flu outbreak and a marauding terrorist firearms attack (MTFA). The five panel members unanimously said the NTS would be the same and in the same order for these three incidents.

The NGT technique did produce a consensus within the group and generally the consensus was strong, as when the participants were asked to select their 'top ten NTS' of the 35 possible NTS, the group consensually narrowed this to eight NTS and were generally agreed on these NTS. Further, the participant weighting scores were also closely aligned. There will always be discussion over the order of NTS in emergency response, but this is a strength of NGT, as it provided a way to consensually agree the ordering with all parties able to influence the outcome.

To keep the proposed emergency response survey questions to a number that could be completed in a reasonable (less than 15 minutes) timeframe to keep respondent fatigue to a minimum, there was a need to limit the number of NTS used in stage two (the survey). The number of NTS was constrained to five to limit the stage two question number; five NTS would produce 26

NTS focussed questions in the survey. The number of NTS used in the survey minimised the burden on respondents.

To achieve five NTS from the 13 re-ranked NTS, they were assessed against the following selection criteria:

a) Applicability to emergency response.
b) Amenability to change within the scope of a HEPE.
c) Inter-connectedness with other NTS.
d) Assessed as an NTS not knowledge/personal quality.

The 13 NTS were reduced to five primary NTS, as shown in appendix B5, by:

- Amalgamating analogous NTS (5).
- Not including those not amendable to change in a HEPE (2).
- Not including an element that was not a NTS (1).

Each primary NTS included a description of the sub-skill descriptors making up the primary NTS. This process produced a robust NTS taxonomy of five primary NTS with associated sub-skill descriptors targeted at health emergency response for use in the main online survey. The five NTS were incorporated into a prototype NTS taxonomy. The NTS taxonomy was named the 'Health Emergency Response Integrated non-technical Skills' or HERIS for short was and applied to stage two.

4.6 Discussion - defining non-technical skills

The research aim was to examine the effectiveness of contemporary health emergency preparedness exercises in enhancing the NTS of health sector staff. Firstly, there needed to be an understanding of what those NTS were for these to then be measured to assess possible enhancement or development. The NGT member's main purpose was to produce a prototype NTS taxonomy that could be applied to stage two, the online survey, to enable an understanding of NTS from the perspective of health sector staff.

NGT, by virtue of the structured method used, produced a ranked NTS list with associated sub-skill descriptors. The principal NGT panel selected 35 NTS from the available 53 candidate NTS (appendix A3) to rank further. From these 35 NTS, 13 were ranked as per the NGT process (appendix B1). This was narrowed to five primary NTS as per the method detailed in this chapter. The NTS selected were decision-making, leadership, situation awareness, communication and team working and were ordered as shown in Table 1. Table 1 also shows the sub-skill descriptors associated with each primary NTS which were refined by the NGT experts.

Table 1. *A prototype NTS taxonomy (HERIS)*

Rank	Skill	Sub-skill descriptors
1	Decision-making	The ability to make a timely decision; clear and decisive; recognise the implications of your actions on yourself and others; accountability of decisions taken; log and document.
2	Leadership	The ability to motivate people to perform and follow your direction; inspire confidence and keep perspective; communicate with others. Manage workload and resources; plan and prioritise.
3	Situation awareness	The ability to gather and understand information; confidence to consider, reassess and reject options. Projecting and anticipating future state.
4	Communication	The ability to communicate efficiently, effectively and in a timely manner with all levels (internal, external, individuals and groups). Clarity of information including context and intent; identifying and tackling barriers to communication.
5	Team working	The ability to coordinate activities and exchange information; supporting others. Use authority and assertiveness; maintain team focus.

This was the prototype NTS taxonomy developed by the NGT. The NTS list was named Health Emergency Response Integrated non-technical Skills (HERIS) and was the NTS used in stage two of the research, the quantitative survey.

It is important to note at this point that this prototype was heavily influenced and informed by the nine key publications outlined in 2.5.1 and shown at appendix A2. The primary skills listed are all included in each of the nine publications, with a minimum of three NTS in publication 2, 3, 7 and 8 and a maximum of all five NTS in publications 1, 4, 6, and 9. However, the key difference is the sub-skill descriptors, these differences in wording were identified by the experts in the NGT. These are different and original and directly relevant to health emergency response.

4.7 Chapter summary

This chapter provided an in-depth overview of the primary qualitative data collection method used in stage one of the study. The chapter provided a critical review of the data collection method selected and explained why this method was the preferred approach. This chapter also incorporated the conclusions of the pilot phases of NGT, analysis of the data collected and a discussion of the significance of the data.

The chapter identified the following key findings:

- Stage one looked for insight into expert attitudes, feeling, beliefs and experiences. After a critical review of the possible methods available and potential bias from insider researching, a NGT was selected as the most appropriate approach as it provided a structured way of producing a feasible list of health emergency response NTS.

- The pilot NGT identified several refinements including the need for participants to have access to a range of NTS to select from during the NGT. These were refined from nine publications.

- Nine key publications provided 53 skill descriptors used by NGT panel members. The NGT members detailed the ten most important NTS needed in a healthcare crisis situation in their opinion. The NGT members went through the recognised 10 step process to produce a viable, informed list of health emergency response NTS.

- There was strong agreement between members on the selected ten primary NTS. The NGT panel members reviewed, assessed and reworded the associated sub-skills of each primary NTS to focus the definitions to heath emergency response.

- The ten primary NTS were assessed against four selection criteria; which were applicability to a health emergency response setting, amenability to change within the scope of a HEPE and the interconnectedness with other NTS. A further criterion was that the NTS was not assessed as knowledge or a personal quality.

- The ten NTS were assessed against a set of criteria to reduce the NTS which were used to develop a prototype taxonomy of five primary NTS for health emergency response. This prototype taxonomy was named Health Emergency Response Integrated non-technical Skills (HERIS). This taxonomy would be used for stage two of the study.

- There was commonality between the primary skills contained in HERIS and other relevant NTS taxonomies selected from the literature, but the sub-skills in HERIS were original. They were developed and honed by the NGT experts to be applicable to health emergency response.

The next chapter describes stage two, the quantitative survey which was an evaluation of participant perspectives on individual NTS development in HEPEs.

CHAPTER 5 – EVALUATION OF PARTICIPANT PERSPECTIVES ON INDIVIDUAL NTS DEVELOPMENT IN HEPES

5.1 Introduction

This chapter articulates the method used in stage two of the study. It provides a critical review of the method selected and explains why this method was the preferred approach. This chapter contains a chronology of the stage and presents the outcomes of the pilot phases of the survey and how this informed subsequent phases. The chapter also includes the analysis of the data gathered during this research stage and describes the analytical activity for each tranche of the data analysis. This is followed by a discussion of the data and inferences that can be drawn and the observations linking these to the literature.

5.2 Context and purpose

A primary objective of the research was to determine the effectiveness of contemporary emergency preparedness exercise to aid in the development of individuals' NTS. From the literature review, the type of exercise selected was a form of HEPE called ETS which was selected as the intervention systems. ETS is described in section 2.2.3. The NTS in question were those identified by the panel of NGT experts as core to an effective health emergency response. Through the evaluation of participants perspectives, a critique of ETS was considered. The overall research aim was supported by four objectives (see section 3.2). Objective two and three were relevant to stage two. They were:

- To conduct a survey of health sector personnel to gain an insight into their experiences from participation in ETS
- To describe and detail the NTS that ETS participants felt were/were not developed as a product of participating in ETS.

Figure 5 shows the chronology of stage two; the activity was conducted over five phases. The surveys and phases (see appendix C1) are explained in

detail in section 5.3; they encompassed three pilot surveys, a cognitive pilot and the main data collection surveys.

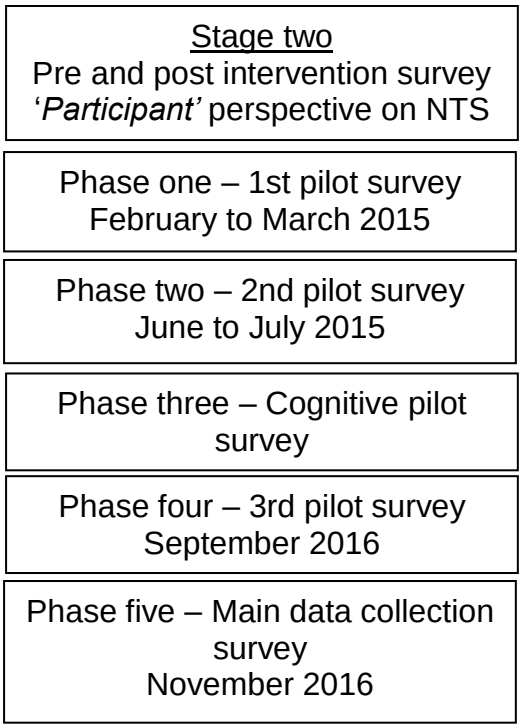

Figure 5. Chronology of stage two

Pivotal to stage two was the development of a method that would enable the collection of NHS personnel perspectives on the effectiveness of a simulation system intervention (ETS) in the development of NTSs from participation in the HEPEs.

An online survey using pre and post intervention questionnaires was considered the most appropriate method to address the objectives and gain the required understanding. The rationale will be explained in this chapter. The purpose of the survey was to gain an understanding from NHS staff perspective of their experience participating in HEPEs of their perceived NTS changes (development). This stage was looking for an insight from the health sector personnel on their personal thoughts on HEPEs and how it aided them individually. It was considered that the survey would contribute to answering the research question by providing an appropriate level of interaction with NHS staff to capture relevant data from a range of people across various

demographic contrasts to determine if HEPEs were indeed aiding in the development of an individual's NTS.

Overall, the route chosen for the stage two data method was to generate and pilot a suitable question set based on the stage one output using the prototype taxonomy (HERIS). The data would then be subjected to variable reduction technique using EFA to explore the underlying factor structure, with a view to developing a set of quantifiable proto-scales that would offer the capacity to benchmark the effectiveness of a HEPE in developing NTS and permit an exploration of demographic variability amongst participants, e.g. by gender, age, current role and previous participation in ETS.

5.3 Method

A key element of stage two was the collection of NHS personnel perspectives on the effectiveness of a HEPE using ETS as an intervention in the development of NTS. Using the literature review to inform the development of stage two, a variety of options were considered, these included interviews either by telephone or face-to-face and the use of self-complete questionnaires either postal or using a web-based system. Each had merits and limitations.

Telephone interviews can be time consuming but generally have a higher response rate than self-complete questionnaires but not as high as face-to-face interviews. Telephone interviews are cost effective when compared to face-to-face interviews, but personal interaction does allow the establishment of a rapport with participants, with each affording the opportunity for clarification of ambiguous questions, unlike self-complete questionnaires. However, as noted by Flowerdew et al., '*interviews reflect self-reported behaviour, rather than actual behaviour, and this may be limited by incomplete recollection*' (Flowerdew et al., 2012, p4). Further, interviewing can take considerable time for both the researcher and the interviewee. The study population were busy NHS personnel and a pragmatic approach was required to balance the requirements of academic rigour with practical

considerations. Due to the availability of these NHS individuals, this made the group difficult to access and recruit. The ETS intervention which was being conducted regardless of the research afforded a useful and convenient opportunity to gain access to this group.

Survey data can provide structured quantitative data on people's attitudes, opinions and experiences (HM Treasury, 2011). However, questionnaires are prone to elicit a low response rate, (Bell, 2010). The Magenta Book by HM Treasury (2011) opine that a common design for a single group is to use 'pre-test and post-test design' when an outcome is measured before and after an intervention takes place but there is not a comparison group available (HM Treasury 2011). One of the main advantages of pre-test/post-test designs is that the associated repeated-measures requires a smaller sample size than other types of analyses such as RCT.

Harris et al., (2004) stated that quasi-experimental designs can be used when it is not feasible to conduct a RCT. RCTs have limitations which include the requirement for large number of participants to give the required level of credibility. Quasi-experimental studies can be completed with fewer participants and are not randomised, enabling the sample to be selected on an opportunity basis. Quasi-experimental studies lack of random assignment can limit the generalisability to a larger population and reduce the internal validity plus the conclusions about causality are less definitive (Center for Innovation in Research and Teaching (CIRT), 2017).

The option of participant observation was considered as this data collection method can offer context and a more in-depth understanding of what is being studied. There are two distinct types; participant and non-participant observation. Participant observation can offer greater insight of the subject being studied. However, it can also have the drawback of affecting the behaviour of those being observed. By the same token, non-participant observation does allow for the use of tools such as cameras or recorders to more accurately capture what is being observed, but this may then provide a more limited insight into the subtleties and context of the subjects being

studied. They are often most effective when used together to develop a comprehensive representation of what is being studied. The lack of participant time along with the researcher's time and availability to travel to multiple ETS events reduced the viability of using the option of participant observation. Also, these data collection methods, being qualitative in nature, would not provide the quantitative type data being sought in this section of the research but is worthy of further research time.

Considering the strengths and weaknesses of the various survey and data collection types and methods, the most appropriate method to address the objectives and gain an insight into NTS development was judged to be a self-complete pre and post intervention questionnaires to maximise sample size and response rate.

5.3.1 Development of the question set

The question set went through a rigorous, iterative sequence of development. The questions were developed to map onto the themes, which were the primary NTS of decision-making, leadership, situation awareness, team working, and communications as identified by the expert panel in the NGT (refer to Chapter 4). It was important that the questions used in the survey had high face validity (were going to measure the respective NTS), were understood by respondents, were meaningful to them and had the potential to elicit reliable and stable data. In particular, for psychometric scales, internal consistency was crucial (within respondent consistency on each dimension). A cognitive pilot addressed issues of face validity, ambiguity and drafting errors for the questions. Further spurious and irrelevant questions were removed during the piloting phases.

Howard and Sharp (1989) note that having a long questionnaire is likely to markedly reduce the percentage of responses and that a low response rate may raise the question of bias (Howard and Sharp, 1989). This principle was applied and the questionnaire was kept short to minimise 'questionnaire fatigue' (Herzog and Bachman, 1981). A key element to keep the survey to a

reasonable completion time was to restrict the number of NTS included in the survey. Five primary NTS were selected, as per the process detailed in section 4.3; five NTS produced 26 NTS focussed questions (appendix C2 shows the NTS focussed questions). To reduce the scope for response-set bias, the question order was randomised and negations of the questions were included (Oppenheim, 1992). The question set was themed to reflect each of the primary NTS identified by the expert panel in the NGT. These were the hypothesised groupings for each NTS and that each NTS would align with the other elements of that NTS group e.g. Team Working one (TW1), TW2, TW3, TW4 and TW5, as per Table 2.

The 26 NTS focussed questions comprised:

- Five questions allowing respondents to allocate an overall score for each NTS.
- 21 questions on the sub-skills of each primary NTS (as per Table 2). These were used to make composite NTS variable for each of the primary NTS and represented the five constructs of: decision-making, leadership, situation awareness, team working and communications and were the hypothesised NTS groupings. (See Appendix C4 for a full list for the questions).

Table 2. *NTS groupings with survey identifiers*

Rank	Primary NTS	Sub-skill descriptors with survey identifiers
1	Decision-making (DM overall)	The ability to make a timely decision (DM1); clear and decisive (DM2); log and document (DM3); recognise the implications of your actions on yourself and others accountability of decisions taken (DM4).
2	Leadership (L overall)	Inspire confidence and keep perspective (L1); manage workload and resources; plan and prioritise (L3); communicate with others (L4); the ability to motivate people to perform and follow your direction (L5).
3	Situation awareness (SA overall)	The ability to understand information (SA1); confidence to consider to reassess and reject options (SA2); projecting and anticipating future

		state (SA3); the ability to gather information (SA4).
4	Communication (C overall)	The ability to communicate efficiently, effectively and in a timely manner with all levels (internal, external, individuals and groups) (C1 to communicate and C4 communicate with). Clarity of information including context and intent (C2); identifying and tackling barriers to communication (C5).
5	Team working (TW overall)	Supporting others [individual] (TW1); use authority and assertiveness (TW2); supporting others [team] (TW3); the ability to coordinate activities and exchange information (TW4); maintain team focus (TW5).

There were a further 24 questions making a total of 50 questions. The survey questions (See Appendix C4 for a full list for the questions) required one of the following responses:

- Yes/no answers (6).
- Free text answers (2).
- Required the respondent to select an appropriate box (15).
- Were scaled using a 5-point Likert scale (27) including 26 which were NTS focussed questions.

Chang (1994) states that '*since Likert (1932) introduced the summative rating scale, researchers have attempted to find the number of scale points item response options that maximise reliability'* (Chang, 1994, p205). A 4-point scale was considered. This scale is commonly used (Borgers, Sikkel, and Hox, 2004); (Østerås et al., 2008); (Leung, 2011). The scale 'forces' an opinion and is sometimes called a 'forced Likert scale' as there is no neutral option. Allen and Seaman (2007) state that a 'forced choice' scale does require the respondent to declare a stance and requires an opinion to be expressed. This type of scale provides an indicative positive or negative opinion and polarises responses. Further, Garland (1991) shows that social desirability bias may be reduced by removing the neutral point and that by having a mid-point may distort the results.

Likert-based response formats may introduce acquiescence bias (when respondents have a tendency to agree with all the questions) and can be common when measuring psychological constructs like NTS. To mitigate this, question can be transformed into a negative version. Respondent are then not obliged to agree with the question (Friborg et al., 2006). In addition to direct and indirect methods, any instrument used in a survey must be valid (i.e. it must measure what it was supposed to measure) and be reliable (i.e. it must yield consistent results repeatedly).

A 5-point scale was judged to have advantages over this scale and other possible scales considered such as a graphic rating; further this is one of the most universally used methods for survey collection. Using a 5-point Likert-type scale with anchors of strongly agree; agree; disagree; strongly disagree, respondents were invited to indicate their agreement with the randomly presented set of statements.

The key strengths of the 5-point format were:

- People are familiar with this format and most will have, at some point, previously completed a survey using a Likert-type scale, therefore would be easily understood by respondents. This was an advantage due to the online nature of the survey.
- The responses from this type of scale are easily quantifiable and can be subjected to analysis and transformed into numerical values. The responses are easier to code because a single number represents each of the participant's responses.
- Ease and speed of completion - it is an effective method for gathering responses. According to Edwards (1997), it has a tendency towards higher completion rates than other alternatives.
- The scale does not require the participant to provide binary yes or no answers, so does not force the participant to take a stance but does allow them to respond with a degree of agreement or disagreement.

A Likert scale does have limitations and drawbacks:

- Central tendency bias - Frequently respondents avoid choosing the extreme options on the scale, even if an extreme choice would be the most appropriate for them.
- A Likert scale can exacerbate the social desirability bias, as respondent would select a positive response i.e. agree or strongly agree.
- Likert scales assume a normal distribution and heavily skewed Likert scales can undermine the resultant statistics that a survey produces. This does not mean that skewed scales are unusable, but that care must be taken with the generality of any results produced. Likert-based response formats may also introduce acquiescence bias; to minimise this, ten of the 26 NTS focussed questions were created as negations of the positive constructs.

Of the 50 questions contained in the questionnaire, 24 questions supported an exploration of an array of potential demographic contrasts e.g. current role and previous participation in ETS to examine the relative impact of the ETS intervention.

The lack of face-to-face contact meant that the questions needed to be designed carefully to avoid ambiguity. Additionally, respondents may wish to elaborate on their answer, but are precluded from doing so with scaled responses. To address this, space was given at the end of the relevant sections of the questionnaire for elaboration. However, if some respondents added extra information and others did not, this may generate difficulty with the categorisation of responses.

The questionnaire was designed for self-completion (Blaxter et al., 2001), therefore needed to have short assessable questions. The questions therefore took the form of short statements designed in such that they were phrased in a precise and unambiguous way. This was to minimise the

likelihood of misinterpretation. All the questions were checked for relevance by continual revision and piloting as per the process detailed in 5.3.3.

A widely recognised issue with questions designed to tap areas such as respondent knowledge and confidence is the risk of questions eliciting social desirable responses (Peterson and Kerin, 1981). In this context, social desirability bias could be described as a '*the desire of respondents to avoid embarrassment and project a favourable image to others*' (Fisher, 1993, p303). In addition, the willingness and ability of respondents to answer questions and the possibility that they might try to anticipate the answer they believed the researcher wanted can produce a further source of bias (Hammersley and Gomm, 1997). This was addressed by carefully wording the questions and omitting those likely to elicit these types of biases.

Similarly, if respondents were asked about sensitive issues, such as their ability in an emergency situation and to self-assess their NTS, there is a risk that they may be reticent to reply honestly if they considered that their responses may have been attributable. This was addressed by briefing the participants clearly and ensuring a level of confidentiality, so participants did not have to justify their responses and could reflect honestly. The responses were coded and no mention of any individual by name or organisation would be included in the research. This was conveyed to participants in the participant instructions (see appendix C3). Names were collected but only to allow responses to be paired from the pre to post intervention survey.

5.3.2 Survey format

Two main survey formats were considered (postal and online). Postal surveys can be sent to many people saving time and making them cost effective; the respondents can answer at their own speed but may take a considerable time to collect. Online surveys have the advantage of being a more cost-effective way of collecting data and reduce administration time involved compared to postal surveys. The whole process could be accelerated by using an online system. PHE has an endorsed and supported

system called SelectSurvey. SelectSurvey is an online tool for creating/sending and managing surveys. Online surveys were considered the most appropriate format. Where respondents do not reply by the requested date, SelectSurvey has the facility to send reminders to participants.

Research indicated that the style and format of the survey can influence response rates (Couper et al, 2004). Based on this, questions were presented in small sections of approximately ten questions per page to make completion of the questionnaire less intimidating than presenting the questions as a continuous list and the order was randomised to avoid order effects bias

Surveys are prone to a low response rate and this can create a bias in the data. To mitigate this, all survey recipients were pre-noted (via SelectSurvey). The pre-note (sent via email) advised the individuals that the online survey was available and asked them to take part. This raised awareness of the survey and its purpose. The pre-note served a further purpose of establishing the email address was correct and live. If the email was not delivered, a system email would be generated to inform the researcher of the non-receipt of the email, allowing a new address to be identified.

5.3.3 Piloting survey items

The pre and post ETS surveys were trialled multiple times with each phase informing the development of subsequent versions. Overall, there were four phases of piloting with *n*=71 completed surveys, followed by the main data collection surveys (as per Figure 5) and detailed in appendix C1.

Phase one – 1st pilot survey

A small-scale internal pilot was conducted (consistent with Blaxter et al., 2001). The internal pilot involved running through all procedures that were planned for the main study. Emergency preparedness specialist volunteers (*n*=13) from the Emergency Response Department at PHE Porton, Wiltshire completed the survey. This pilot indicated that the survey took approximately

ten to 15 minutes to complete (consistent with Howard and Sharp, 1989). The pilot prompted the addition of the consent form at the start of the survey and some minor wording changes. This resulted in a clearer question set and enabled the consent to be given in advance of starting the survey.

Phase two – 2nd pilot survey

A second pilot was conducted at an ETS event in London, to test the effectiveness of revisions arising from the first and to conduct the survey with a larger sample (*n*=19) and considered to be potentially more representative of the ETS population. Analysis revealed that a high proportion of items exhibited modest variance and notable skew. The limited range of response was considered unsatisfactory to use in the main data collection surveys and the following improvements were identified.

The pilot identified two areas for improvement.

1. The question format was not sufficiently complex to extract the required data in the pilot format. The format was revised to use a different scale (5-point Likert-type anchors of 'strongly agree' to 'strongly disagree' rather than four). This scale was selected as it is a proven scale for Social Studies.

2. The survey questions lacked a depth and complexity about each NTS. The NTS questions were expanded to include the sub-skills descriptors for each of the five primary NTS (Table 2). This added a further 15 questions which, when combined during the analysis of the data, would provide a composite NTS score for each of the five NTS constructs of: decision-making, leadership, situation awareness, team working and communications.

Phase three and four – Cognitive pilot and 3rd pilot survey

To improve confidence in the robustness of the survey, a cognitive pilot was conducted with a sample (*n*=8) drawn from ERD, PHE Porton to test question

clarity and ambiguity. Comments indicated that the survey was suitable for a further pilot to test in a wider more rigorous pilot. A third and final pilot was conducted with a sample (*n*=18) drawn from an NHS Trust in Bristol which indicated that the surveys (pre and post ETS) were suitable for the larger scale main data collection.

5.4 Survey ethics

Participants were recruited via email and informed that their participation was voluntary, and they were free to withdraw from the study at any point without giving any reason. They were assured of anonymity and that their contribution would be reported using a non-attributable form (a copy of the University of Bath, Department for Health Research Ethics Approval for this study is provided at appendix B2). The email also contained an introduction to the researcher, an information letter about the survey (appendix C3) and a link to the online portal (SelectSurvey). The consent form (which was completed online) is shown at appendix C5. The timing of the email was carefully selected to arrive just after an email had been sent to participants by the PHE that directed them to a pre ETS online e-training package. This was judged as good practice to coincide both emails to focus the participants on the training and provide an informal channel for the researcher to the potential participants.

5.5 Data collection

The ETS survey was launched in November 2016. It was designed to capture participant experience pre and post their ETS exercise event.

ETS was selected as the intervention (see section 2.2.3) as ETS is typical of a contemporary HEPE and is used regularly in the NHS. This system was readily available to the researcher was considered by the nature of its delivery, conduct and availability suitable to be used in the research. ETS provided a controlled, repeatable and safe environment in which to exercise NHS personnel in a representative (health emergency response) simulation situation. ETS events typically have approximately 50 to 120 participants.

Each ETS follows a common approach and delivery methodology which makes them comparable regardless of the emergency scenario or location. Historically, there have been multiple ETS events delivered every year by ERD staff from PHE Porton based at Porton Down in Wiltshire. This was a key reason that ETS was chosen as the intervention for the research.

5.5.1 Sample

Participants in the study were NHS emergency response personnel attending ETS events in England (*n*=266). These participants were considered to be representative of NHS personnel from NHS Trusts across England. Consequently, it is assumed that any outcomes will be applicable to this population.

Participants were sampled from the training participant database of ETS events delivered in 2015/6. They were an opportunity sample of volunteers and were invited to complete a pre and post ETS evaluation survey This had the advantage of being an expeditious way of choosing participants but the consequence of this convenience sample may be that an unknown part of the population may have been excluded (Herek, 2012) as discussed in section 3.5.1.

Due to circumstances beyond the researcher's control, in 2016 (the year of main data collection), the programme was changed from small targeted NHS Trust level exercises to much larger regional trauma network area exercises. This transition to larger exercises required a considerable period of preparation and reduced the number of events, and therefore participants, from the usual 24 ETS events to three. This reduced the expected sample population significantly from approximately 1250 to 250 potential participants. However, in view of the pre-post design, a sample of 250 was judged to be sufficient to detect a small effect size. The prediction of a small effect size was considered prudent in view of the limited evidence base on the role of NTS skills within emergency preparedness training (Paterson et al., 2016).

The survey was sent to all nominated participants, as per the process confirmed as appropriate in phases one to four. 266 people were pre-noted and 158 completed either the pre and or the post survey questionnaire (return rate 59%). Of these 158 questionnaires, 50 were completed (pre and post), generating a sample of *n*=50 (survey return rate was 32%). This was the sample used for data analysis.

Table 3 shows the demographic breakdown of the data sample. 62% of the respondents were female and the majority (88%) were nursing, medical or clerical staff professional role. 90% were in the age range from 36 to 55. Appendix C6 and C7 shows the data in graph format.

Table 3. *Sample demographics*

Current role	Age range					Gender assignment		
	26-35	36-45	46-55	56-65	Total	Male	Female	Total
Clerical/manage-ment Staff	1	5	8	1	15	7	8	15
Deputy Emergency Planning Manager	0	1	0	0	1	0	1	1
Emergency Planning Officer	0	1	0	0	1	1	0	1
Healthcare Chaplain	0	0	1	0	1	0	1	1
Medical Staff	0	8	5	0	13	9	4	13
Nursing Staff	2	3	10	1	16	2	14	16
Other health professional	0	1	2	0	3	0	3	3
Total/(%)	3 (6%)	19 (38%)	26 (52%)	2 (4%)	50	19 (38%)	31 (62%)	50

The majority of the sample was in the age brackets 36 to 55 (90%) and most (62%) were women. Based on the data available on NHS Digital[15], the NHS is made up of 44% female and 56% male (only 25% of the NHS workforce in

[15] NHS workforce demographics 2017 available at https://digital.nhs.uk/about-nhs-digital/corporate-information-and-documents/how-we-support-diversity-and-inclusion/our-workforce-demographics-2017

surgery disciplines are women) and age 25 - 34 = 18%, 35 – 44 = 37% and 45 – 54 = 29%.

This data would suggest a systematic bias in favour of women, with 18% more women in the sample than the overall NHS workforce demographics. Further, the sample had a higher percentage (90%) of the age groupings 36 to 55 than the NHS demographic which was 65% for this age group. NHS workforce demographics (2017) indicated that the NHS employed (full-time equivalent): 106,430 doctors; 285,893 nurses (89% of which are women) and health visitors; 21,597 midwives; 132,673 scientific, therapeutic and technical staff; 19,772 ambulance staff; 21,139 managers; and 9,974 senior managers. Most of the sample were made up of medical, nursing or clerical staff. This may suggest that the medical and clerical staff were over-represented in the sample, however this may be more representative of an ED and staff that are part of an emergency response in a healthcare setting. Further the sample had a large percentage of nursing staff who, according to the 2017 data are predominately woman (89%) this may have affected the gender bias to women.

5.6 Data analysis - Assessment of the contribution of ETS to NTS development

The survey was formulated with the purpose of gathering quantifiable data relating to the development of NTS as a result of participating in an ETS. A summary of the survey results is shown at appendix C8. This section describes the descriptive analysis of a range of contrasts.

5.6.1 Descriptive analysis

The survey responses were used to explore whether there was a statistical relationship between the questions. A descriptive analysis is shown in section 5.6.1 and includes a comparative analysis of demographic contrasts (5.6.1.1.); a comparative analysis of ETS participation (5.6.1.2) and a comparative analysis of the composite NTS (5.6.1.3). Each of the three sub

sections incorporates a short summary. This is followed by a discussion of the entire comparative analysis.

5.6.1.1 Comparative analysis of demographic contrasts

To explore the extent to which respondents rated the primary NTS and how this varied by experience and a range of employment demographics, e.g. gender, age, current role and previous participation in ETS, a range of demographic data was collected. This section will present the descriptive data and will include gender assignment, age range, current professional role, time in emergency response role, training received and previous participation in ETS.

Respondents were asked if they were currently in a designated emergency response role and, if so, how long had they been in the role. The table in appendix C9 indicates that 68% of respondents had an emergency response role, of which 50% had been in the role for more than three years.

Respondents were asked if they had received emergency response training and if the training had targeted NTS. The table in appendix C10 indicates that 82% of respondents had received emergency response training; a majority (68%) of these had received that training in the previous two years. Of those who had received training, only 32% assessed the training as targeting NTS. Respondent were asked post ETS, if they had received emergency response training and although it was the same 50 respondents used in the pre ETS sample, five people responded that they had not had training.

They were also asked if they considered the training aided their participation in the ETS. Appendix C11 indicates that of those who had received training, 60% considered the training had aided their participation in the ETS.

Respondents were asked if they had ever responded to a large-scale emergency and, if so, how many times. Appendix C12 shows that only 28%

of respondents had first-hand experience of participation in emergency response; and the majority of this group (64%) had only responded to one emergency.

Respondents were asked if they had participated in an ETS before and if so how many times. The table in appendix C13 indicates that 64% of respondents had not participated in an ETS before. Of those that had participated before, the majority (61%) had only participated once before.

Respondents were asked why they were participating in the ETS. The table in appendix C14 shows that four main reasons were selected. These were respectively to improve ability in current role; to develop responder skills; for individual development; and ETS was a compulsory activity. These four reasons equated to 88% of responses.

Respondents were asked pre and post ETS about their ability and confidence to respond to an emergency. The table in appendix C15 shows that pre ETS, 88% felt able to respond to an emergency; 100% gave a 'yes' response post ETS. 70% of respondents selected the anchors 'agreed' or 'strongly agreed' that they felt confident to respond to an emergency pre ETS. This increased to 96% confidence post ETS, with 86% agreeing that they felt their ability to respond had increased.

- Summary of the comparative analysis of demographic contrasts

  Most respondents had an emergency role (68%) and half had been in the role for more than three years. 82% had received emergency response training with most (68%) having received that training in the last two years. Of those that had responded to a real emergency, 72% had only responded to one emergency. 64% of respondents had not participated in an ETS before and 54% were doing ETS to improve their ability in a current role and to develop their responder skills.

When asked about ability and confidence to respond 88% felt able to respond to an emergency (pre); and 100% felt able to respond to an emergency post ETS. 70% of respondents felt confident to respond to an emergency pre ETS compared to 96% (post ETS).

5.6.1.2 Comparative analysis of ETS participation (pre and post)

This section presents a comparison and contrasts of respondents' pre and post ETS intervention ratings using the 26 NTS focussed questions (see section 5.3.1) which were made up of five questions on overall NTS scores and 21 sub-set questions on each NTS. To allow a numerical score to be allocated to each of the 26 NTS focussed questions, the scores for each of the questions from the sample responses were added together for each question. Each anchor was allocated a value from one to five e.g. strongly agree = 5 and strongly disagree = 1. If the questions were negations of the question statement, the values were reversed.

The table in appendix C16 shows a comparison of the total score for each NTS pre ETS and post ETS using the five overall NTS focussed questions. By adding the values together, the pre ETS items had the following values: summed score values were between 199 and 215; mean values were between 3.98 and 4.30; standard deviation values between .463 to .566; skewness values between -1.271 to .396; and kurtosis values between -0.724 to 7.128. The post ETS items had the following values: summed score values were between 201 and 215; mean values between 4.02 and 4.30; standard deviation values were between .438 and .527; skewness values were between -1.134 to .925; and kurtosis values between -0.724 to .899.

This shows that four of the five NTS had an increased sum score when added together from pre to post ETS. The NTS for overall team working showed the same sum score i.e. the same pre to post ETS.

A reliability analysis of the five questions on overall NTS (pre and post items = 10 items) revealed a Cronbach's alpha[16] of 0.729 pre and 0.816 post indicating an acceptable internal consistency in the measures used. All questions were positively correlated. These overall NTS questions were not part of the hypothesised scale. This scale was for each primary NTS to align with the other elements of that NTS group such as e.g. DM1, DM2, DM3, DM4 (as per Table 2). This was conducted on the 21 sub-set questions.

Appendix C26 shows a comparison of the pre and post ETS 21 sub-set questions. A numerical score was determined for each of the 21 NTS focussed responses. The pre ETS items had the following values: sum values were between 121 and 214; mean values between 2.42 to 4.28; standard deviation values were between .497 to .859; skewness values between -2.06 to 1.06; and kurtosis values between -0.57 to 10.36. The post ETS items had the following values: sum values were between 115 and 225; mean values between 2.30 to 4.50; standard deviation was between .422 and .863, skewness values were between -2.38 to 1.15; and kurtosis values between -2.09 to 14.01.

This shows that 20 of the 21 sub-set NTS questions indicated an increased mean score from pre to post ETS. Only team working 1 (TW1) showed a decrease.

A reliability analysis of the 21 questions (pre and post items = 42 items) revealed a Cronbach's alpha of 0.87 pre and 0.85 post. All items were positively correlated, and all 42 items showed internal consistency. No questions were deleted at this point. However, a further analysis was conducted for the composite NTS variables (when NTS sub-set questions were grouped by NTS) and is presented later in this section.

Respondents were asked post ETS about the NTS they used during ETS. The table in appendix C17 reports that leadership, followed by communication

[16] Cronbach's alpha is a measure of internal consistency and scale reliability

were the most cited NTS used in the ETS. Some respondents cited the use of multiple NTS and others reported that they had applied NTS not included in the study. Details of these additional NTS are included for completeness.

Respondents were asked post ETS about the primary NTS they considered had been changed by participation in the ETS. The table in appendix C18 shows that 38% of respondents believed that their situation awareness was the most changed. However, 34% cited no change to primary NTS post ETS. Other elements were mentioned as having been changed, although the majority (86%) said no other NTS were changed. The 14% that made comment added the following elements: identifying roles and responsibilities; awareness of other organisations; confidence and assertiveness; multi-disciplinary effects; strategic awareness; and working under pressure.

Respondents were asked to comment post ETS on reasons they believed their NTS may have changed as a result of ETS participation, appendix table C19 shows that 38% responded that they did not feel any change had taken place, 26% selected that perceived changes could be attributed to ETS participation and 22% stated that the changes were due to a raising of awareness of skills they already had.

Respondents were asked to rank the primary NTS in order of importance pre and post ETS, in terms of which NTS they considered were needed to enable them to respond effectively to an emergency. The NTS were ranked from one to five. This was to provide comparative data with the NGT ranking, as determined by the expert panel but also to compare the ranking pre and post ETS. Appendix C20 shows that the NGT panel ranked decision-making as the principal skill required to respond effectively in an emergency. The ETS participants ranked communications as first both pre and post ETS. The only common factor between the three sets of rankings was team working at number five. The pre and post ETS rankings stayed almost the same with only leadership and decision-making changed position post ETS with leadership ranking fourth.

❖ Summary of the comparative analysis of ETS participation

In summary, this section shows that four out of the five overall NTS mean scores (apart from team working) increased from pre to post ETS and 20 of the sub-set NTS scores (apart from TW1). Respondents indicated that leadership and communication were the most used skills in the ETS and that situation awareness was the most changed. The majority of respondents cited that the perceived changes were due to either participation in ETS (36%) or raising awareness of skills they already had (22%).

5.6.1.3 Comparative analysis of the composite non-technical skills

This section presents a comparison and contrast of respondents' pre and post ETS intervention scores using the 21 sub-set questions amalgamated into their respective primary NTS from HERIS (as per appendix C26) as a composite NTS score representing each of the five NTS constructs. There are four distinct data analytical processes included. These are lettered a to d:

a) A comparison of pre and post ETS primary NTS mean scores.
b) The composite NTS variable data pre and post ETS intervention.
c) A series of repeated measures Analysis of Variance (ANOVA) analysis against the null hypothesis.
d) A series of repeated measures ANOVA analysis against the four 'between subject' variables (labelled i to iv).

The four 'between subject' variables were:

i. A current emergency response role.
ii. Whether a participant had received emergency response training.
iii. Whether a participant had ever responded to a real emergency.
iv. If the respondent had ever participated in an ETS before.

The null hypothesis was that there was no change in participants' composite NTS scores when measured before and after participation in the ETS intervention.

a) A comparison of pre and post ETS primary NTS mean scores

A series of paired sample t-tests were conducted on the 26 questions specifically focussed on NTS. Firstly, the five overall NTS questions, which provided a single score for each of the primary NTS, these were situation awareness, decision-making, communication, team working and leadership. The table in appendix C21 shows the paired sample t-test results for the five NTS mean scores.

b) The composite NTS variable data pre and post ETS intervention

A paired sample t-test was conducted on the 21-item measure. Appendix C27 shows a paired t-test analysis and groups the 21 questions into each of the five composite NTS groups. The table reveals that all 21 items showed an increase in mean score from t1 to t2, apart from pair 13 (team working 1 (TW1)) which showed a slight decrease. TW1 was identified as an outlier in the data set and was excluded in further data analysis.

The 21 NTS questions were amalgamated into five NTS variables according to the method outlined in 5.6.1.3. This provided a composite mean score for each of the NTS. A further reliability analysis was then conducted with each composite NTS sub constructs (pre and post ETS) with all 21 items included. This revealed a Cronbach's alpha of between .702 (communication) to .186 (team working) pre ETS: and .736 (decision-making) to -.530 (team working) post ETS. Further inspection of the results indicated that if items DM2.1, SA2.1, C1.1, TW1.1, L1.1, SA2.2 C5.2, and TW1.2 were deleted, this would increase the Cronbach's alpha of the composite NTS scores. Individual Cronbach's alpha scores were re-calculated after the deletion of the eight questions to ensure the internal consistency of the data for each composite NTS variable and appendix C22 shows that Cronbach's alpha varied from .750 to .482.

The table in appendix C23 shows the mean values of the composite NTS variables pre and post ETS. This shows that all five composite variables showed an increase from pre to post ETS (T1 to T2). The difference in mean scores varied from 0.34 to 0.01, with situation awareness showing the largest difference and communication showing only a 0.01 change.

From Appendix C26, it can be seen, that mean scores for some items are peaked or kurtotic. T1 kurtosis range is between -0.57 and 10.36 and for t2, the kurtosis range is -2.09 to 14.01. Due to some concern with the normality of the data (data should be normal as pre-requisite of conducting parametric tests), a more conservative (non-parametric) paired-samples t-test Npar Wilcoxon S-R test were performed on the composite NTS variables.

The table in appendix C24 shows the non-parametric results of the Npar Wilcoxon S-R test. Non-parametric tests do not assume normal distribution as described by the mean and standard deviation. This showed there was an increase in composite NTS mean scores for all primary NTS from t1 to t2. The non-parametric scores are consistent with the parametric results paired samples t-tests (as per appendix C23).

c) A series of repeated measures ANOVA analysis against the null hypothesis

A one-way repeated measures ANOVA was conducted to evaluate the null hypothesis that there was no change in participants' composite NTS mean scores comparing before and after participation in the ETS intervention (n=50). The results of the ANOVA indicated a significant change in the NTS situation awareness: Wilks Lambda = .69 F (1, 49) = 22.27 p<0.001 n2 = .31. Thus, there was significant evidence to reject the null hypothesis.

Table 4 below shows that the null hypothesis can also be rejected for decision-making, team working and leadership but not communication.

Table 4. *Analysis of one-way repeated measures*

Composite NTS skill	Results	
Situation awareness	Wilks' Lambda = .69 *F* (1, 49) = 22.27 *p* <0.001	n2 = .31
Decision-making	Wilks' Lambda = .80 *F* (1, 49) = 12.35 *p* =.001	n2 = .20
Communication	Wilks' Lambda = .99 *F* (1, 49) = .103 *p* =.749	n2 = .002
Team working	Wilks' Lambda = .80 *F* (1, 49) = 12.23 *p* =.001	n2 = .20
Leadership	Wilks' Lambda = .86 *F* (1, 49) = 8.08 *p* =.007	n2 = .14

Follow up comparisons indicated that the pairwise difference was statistically significant with a difference between each pair of time points with a mean difference of .333, std error .071, *p*<0.001.

There was a significant increase in mean scores from before to after the ETS intervention, suggesting that participation in the ETS increased participants NTS score for situation awareness. Four of the five NTS (excluding communication) indicated that the increase was significant as shown in Table 4. The effect size measured using Partial Eta Squared varied from .14 to .31 showing a medium to large effect size (using small .02. med.13, large .26 effect sizes).

d) A series of repeated measures ANOVA analysis against the four 'between subject' variables

A series of one within one between measures ANOVA were conducted to assess if participants' composite NTS scores would improve more from t1 to t2 as a result of the ETS participation, using four between-subject factors of: current emergency response role; whether a participant had received emergency response training; whether a participant had ever responded to a real emergency; and if the respondent had ever participated in an ETS before.

A one within one between ANOVA was performed to assess if situation awareness composite NTS in those not in an emergency response role would improve more from t1 to t2 as a result of the ETS participation, compared to those who were already in an emergency response role. There was no significant interaction Wilks' Lambda = .992, *F* (1, 48) = .364, *p* = .549. There was however a significant main effect of participation in the ETS, Wilks'

Lambda = 695, F (1, 48) = 21.081, p<0.001, Partial Eta Squared =.305. Both groups showed a significant improvement from t1 to t2.

If we then conduct the same analysis on the other four composite skills, there was no significant interaction Wilks' Lambda for decision-making F (1, 48) = .042, p = .839; for communication F (1, 48) = .825, p = .368; for team working F (1, 48) = 2.272, p = .138; for leadership F (1, 48) = .989, p = .469. This shows that those who have a current emergency response role had composite NTS scores no higher than those with no current emergency response role before or after the ETS intervention.

If we then compare the difference between the other three between-subject variables: whether a participant had received emergency response training; whether a participant had ever responded to a real emergency; and if the respondent had ever participated in an ETS before, we find no significant differences from T1 to T2. However, all composite NTS, apart from communication, significantly improved as a result of participation in the ETS. Appendix C25 shows that the between-subject variable group sizes for each of the four between factor subjects were very uneven in size and because of the uneven group sizes. The interpretation of the results has some limitations which will be covered in the discussion chapter.

- ❖ Summary of the comparative analysis of the composite non-technical skills

Summary of (a) - This data showed that four of the five primary NTS mean scores increased from t1 to t2, apart from team working, which had the same mean score pre to post ETS. This is consistent with appendix C16.

Summary of (b) - After using the more conservative, non-parametric test, there was an increase in all the NTS composite mean scores pre to post ETS. Appendix C26 indicated that the mean scores for some questions were kurtotic and a more conservative (non-parametric) one-way repeated measures ANOVA test was performed on the composite NTS variables. Overall, the non-parametric test showed statistically significant difference between the mean ranks of the related groups t1 to t2 in composite NTS score $\chi^2(2) = 84.447$, p <0.001.

Further, the analysis revealed that all five composite NTS variables displayed an increase from pre to post ETS (t1 to t2). To compensate for the peaked nature of the data, a (nonparametric) Npar Wilcoxon S-R test was conducted that showed that there was an increase in the composite NTS mean scores for all primary NTS from t1 to t2 which was consistent with the parametric analysis.

Summary of (c) - There was a significant improvement in NTS mean scores from before the ETS intervention to after ETS intervention for four out of the five NTS composite variables (situation awareness, decision-making, team working and leadership). There was no significant improvement in communication skills because of the ETS intervention.

Summary of (d) - Already being in an emergency response role; or having already received emergency response training; or having already responded to an emergency or having participated in ETS before, did not add significantly to the development of any NTS composite variables. This assertion was supported as participants results were no higher pre to post ETS regardless of experience in these areas.

5.6.2 Discussion of the comparative analysis

To assess the contribution of a simulation system (using ETS) to NTS development and to explore the extent to which respondent scores varied by experience and a range of demographics and to evaluate against the null hypothesis, a series of comparisons and contrasts were undertaken.

These tests showed that overall there was a significant difference between each pair of time points (t1 to t2) for four of the five primary NTS after participation in the simulation. These four NTS were situation awareness, decision-making, team working and leadership. The NTS communication did not show a significant difference. However it was cited by respondents as the second most used primary skill in the ETS intervention. Riem et al. (2012) stated that '*both technical skills (TS) and non-technical skills (NTS) are key to ensuring patient safety in acute care practice and effective crisis management. These skills are often taught and assessed separately'* (Riem et

al., 2012, p723). Overall, it may be reasonable to conclude that the quantitative results suggested the utility of a simulation system such as ETS to support the development of NTS. However, to develop communication NTS may require an adjustment to the ETS system to enable effective development of this NTS.

The utilisation of the NTS situation awareness in the ETS intervention was not mentioned by respondents but was cited as the most changed NTS by the simulation system, with 38% considering it affected. There were other elements cited as being utilised, but the elements could be categorised as knowledge or technical skill and not considered further as per the rationale outlined in chapter 2. This result was consistent with the 86% of respondents saying that no other skills were changed.

34% of respondents said that they had not perceived any change to any primary NTS from pre to post intervention. This was not consistent with most respondents paired t-tests which showed increased mean scores pre to post the intervention. This inconsistency could indicate a degree of sensitivity of the survey to measure the primary NTS that was not evident to the respondents when asked a single question about overall NTS development (from the five overall NTS questions). It could also indicate that when presented with a concise question asking if they had perceived a change in primary NTS, they took the opportunity to say no.

The results also showed that 38% of respondents did not consider there was any change to their NTS as a result of participating in the simulation system. This seems to mirror the finding of 34% of respondents not feeling there was any change to primary NTS but is inconsistent with the paired t-tests. In fact, 74% felt that any perceived NTS changes were more to do with reasons other than participation in the intervention. These included raising awareness of skills already possessed or previous training rather than participation in ETS. Only 26% considered the intervention as the mechanism in their NTS development. This inconsistency does not endorse ETS as an effective NTS exercising system; however, the fact that 48% of respondents were more

enlightened about their NTS after the ETS exercise would suggest that it was worthwhile in highlighting NTS to respondents.

5.7 Exploratory Factor Analysis

This section presents the analysis of the data sample using EFA. EFA is a technique (within factor analysis) used to identify underlying factor structures of measured variables. The EFA analysis used the 21 sub-skill questions (a sub-set of the 26 NTS focussed questions).

The EFA was conducted to explore the presence of underlying constructs based on statistical associations between the measured variables. This was to test the fit with the theorised groupings. Methodologically, it was considered that a quantitative approach based on EFA, not only reflected mainstream practice in complementary areas such as workplace safety but offered advantages in respect of refining the NTS themes from stage one into an underlying set of constructs.

The EFA showed the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.75, and the Bartlett's test of sphericity was highly significant (χ^2=332.03, *df*=105, *p*<0.001). According to these two tests, the correlations and partial correlations between the items implied the existence of latent factors. The scree plot (Figure 6) indicated a three-factor solution that explained 59.3 % of the variance.

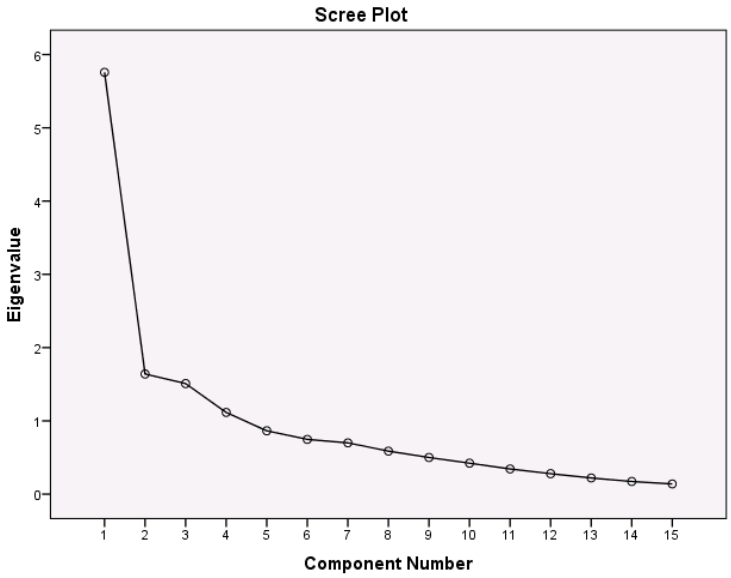

Figure 6. Scree plot of the Exploratory Factor Analysis

The three-factor solution items were grouped as per the pattern matrix in Table 5.

Table 5. *Three factor solution from the EFA*

Sub-skill item	Group 1	Group 2	Group 3
SA4.1 I find it difficult to maintain situation awareness	.849		
TW5.1 I find it difficult to maintain team focus	.822		
L4.1 I find it difficult to manage workload and resources	.623		
DM2.1 I find it difficult to log and document decisions I have made	.622		
SA3.1 I feel I am able to project and anticipate future states to maintain situation awareness	.508		-.307
TW2.1 I find it difficult to use authority and assertiveness as part of a team		.900	
C4.1 I feel confident communicating with all levels (internal, external, individuals and groups)		.778	
SA2.1 I lack the confidence in my ability to consider, reassess and reject options		.670	
L5.1 I have the skills to motivate people to perform and follow my direction		.639	

C5.1 I find it difficult to get people to listen to what I have to say	.404	.523	
TW3.1 I feel confident working as part of a team			-.776
SA1.1 I feel confident in my ability to gather and understand information to develop situation awareness			-.747
DM1.1 I feel confident that I have the skills to make timely decisions	.309		-.617
TW4.1 I feel I have the ability to coordinate activities and exchange information as part of a team			-.601
DM4.1 I recognise the implications of my actions on myself and others		.495	-.550

5.8 Naming of constructs

Based on the properties the EFA constructs contained (as shown in Table 5), they were categorised as personal effectiveness (group 1); assertiveness (group 2); and self-awareness (group 3).

The EFA construct names of personal effectiveness, assertiveness and self-awareness were determined from the characteristics of the sub-skills grouped in each factor.

> Personal effectiveness construct included sub-skills of maintenance of objectives such as situation awareness and team focus and managing workload and time. These sub-skills are consistent with being personally effective.
>
> Assertiveness had sub-skills of authority, confidence in communication and ability and motivation of people, all sub-skills are consistent with assertiveness.
>
> Self-awareness had sub-skills related to confidence and ability to coordinate within teams and decision-making and recognising the impact of personal actions on others. These sub-skills are consistent with being self-aware.

The following definitions were identified for each of the new EFA factor constructs:

- Personal effectiveness - making use of all the personal resources at an individual's disposal - talents, skills, energy and time, to enable them to achieve both work and life goals. This is consistent with Balaji and Somashekar, (2009) of personal effectiveness as an NTS.

- Assertiveness - a skill characterised by '*creating a proper challenge and response atmosphere*' (Flin et al. 2003). This is consistent with (Flin et al. 2002) and Fletcher et al. (2003) as an NTS.

- Self-awareness - is about an individual having a clear perception of their personality, including strengths, weaknesses, thoughts, beliefs, motivation and emotions. Self-awareness allows an individual to understand other people; how they are perceived, understand their attitude and their responses to people. This was consistent with a personal quality Donahue (2017).

The original hypothesis was that the question set reflected the five primary NTS skills constructs as identified by the NGT experts. However, the EFA indicated that the elements measured were more appropriately characterised as reflecting three new groupings of variables. Table 6 shows a comparison between the hypothesised groupings and the EFA findings. The table shows the new EFA constructs were a mixture of at least three different NTS variables.

Table 6. *A comparison of theorised and EFA constructs*

Hypothesised constructs

Communication	Decision-making	Leadership	Situation awareness	Team working
C1 C2 C4 C5	DM1 DM2 DM3 DM4	L1 L3 L4 L5	SA1 SA2 SA3 SA4	TW1 TW2 TW3 TW4 TW5

New factor constructs from EFA

EFA constructs	Personal effectiveness	Assertiveness	Self-awareness
	SA4 L4 DM2 SA3	TW2 SA2 L5 C5	TW3 SA1 DM1 TW4 DM4

It was noteworthy that the three EFA constructs were clearly delineated (Table 5) and could be characterised.

5.9 Measure development

> '*Many instances exist in which the researcher cannot find an adequate or appropriate existing scale to measure an important construct. In these situations, it is necessary to create a new scale*'
>
> (Hinkin et al., 1997, p2)

Hinkin et al., highlighted that there is not always an existing scale available to use as a measure. This was consistent with Reedy et al. (2017). The sub-skill questions (as per appendix C2) were the basis for the development of a proto-scale with the following constructs: decision-making, leadership, situation awareness, team working and communications. These were the hypothesised groupings for the scale. The EFA demonstrated that the constructs could be reduced to three new factor constructs and that this 13-point measure could be used to measure these constructs.

5.9.1 Scale development

Using item analysis (Spector, 1992), the factors were refined to develop a viable set of proto-scales. An EFA of the 21 items using a maximum likelihood method extracted factors with eigenvalues greater than one, was conducted. A reliability analysis was conducted on each of the new skill factors. This indicated an improvement in Cronbach's alpha if eight items were excluded; this was to give the highest resolution of factors. These items were L1, C1, DM3, L3, C2, C4, TW5 and TW1; TW1 was an outlier of the data set. The Cronbach alphas were recalculated and are shown in Table 7. This refinement was conducted to ensure that the proto-scale had an acceptable internal consistency.

Table 7. *Cronbach's alpha for the new skill factor constructs*

EFA skill factor constructs	Cronbach's alpha
Personal effectiveness	.800
Assertiveness	.792
Self-awareness	.814

5.9.2 Comparison of pre and post ratings

A paired-sample t-test was conducted to compare the pre and post ETS intervention ratings for each EFA construct. There was a statistically significant increase in ratings from t1 (pre ETS) for each of the three new factor skill constructs. Table 8 shows that all three new factor constructs had an increased mean score when comparing pre to post ETS. The paired sample test indicated that personal effectiveness and assertiveness had significant p values of $p<0.001$ and self-awareness was $p = .002$.

Table 8. *Paired sample t-test for the new factor skill constructs*

		Mean	N	Std. Dev	Std. Error Mean	t	Sig.
Pair 1	Personal effectiveness pre	3.63	50	0.538	0.076	-5.08	.000
	Personal effectiveness post	4.01	50	0.368	0.052		
Pair 2	Assertiveness pre	3.73	50	0.484	0.068	-3.38	.000
	Assertiveness post	3.96	50	0.393	0.056		
Pair 3	Self-awareness pre	4.06	50	0.355	0.050	-3.28	.002
	Self-awareness post	4.22	50	0.374	0.053		

ANOVAs were conducted (see Table 9) to assess if the degree of improvement varied with reference to the structural demographics of:

i. Having a current emergency response role.
ii. Whether a participant had received emergency response training.
iii. Whether a participant had ever responded to a real emergency.
iv. If the respondent had ever participated in an ETS before.

A 'one within one, between' ANOVA was performed to assess whether the degree of enhancement from ETS participation varied between participants who were not already in emergency response role, compared with those who did have a role. There was no significant interaction apparent. Wilks' Lambda = .993, F (1, 48) = .347, p = .559. There was, however, a significant main effect of participation in the ETS, Wilks' Lambda = .664, F (1, 48) = 24.278, p <0.001, Partial Eta Squared =.336. Therefore, both groups showed an improvement from t1 to t2.

A further series of comparisons were conducted to compare the difference between the other three structural demographics (as identified above ii to iv). The Wilks' Lambda results revealed no significant results of p=<.05. This indicated that none of the respondent structural demographics added significantly to the development of any of the new factor skill constructs. All

new factor skill constructs showed a significant main effect of participation in the ETS.

Table 9. *New EFA constructs p values*

Between subject factors	Current emergency response role		Received Emergency response training		Responded to real emergency		Participated in ETS before	
	Between subject	ETS	Between subject	ETS	Between subject	ETS	Between subject	ETS
Personal awareness	.559	.000	.602	.000	.429	.000	.451	.000
Assertiveness	.867	.001	.891	.007	.059	.010	.853	.001
Self-awareness	.209	.001	.773	.010	.180	.022	.734	.004

This would indicate that already being in emergency response in an emergency response role, or having received emergency response training, or having responded to an emergency before or having participated in ETS before, did not add significantly to the development of any of the new factor constructs. This assertion is supported by analysis indicating that none of the participants had significantly higher post ETS scores for the new factor constructs compared to pre ETS scores than those who had no emergency response role, or had no training, or had responded before or had participated in ETS previously. However, ETS participation did indicate a significant main effect on the new EFA factor scores for all three factor constructs.

5.10 Discussion – NTS survey interpretations

Research had indicated that there were no available HEPE NTS measurement tools (with demonstrable reliability). This is consistent with Reedy et al. (2017) who note that '*there remains no valid, reliable tool for assessing the knowledge and learning of human factors skills in healthcare training, which limits development and evaluation of training interventions* (Reedy et al., 2017, p1). So, a new bespoke tool was developed for the research (Hinkin et al., 1997).

To explore the possibility of there being underlying structures and that the survey may have been measuring some as yet undiscovered or unanticipated skill or personal quality in the data collected by the newly developed bespoke NTS survey (using a 21-question measure), an EFA was conducted. This was to statistically determine whether the questions were measuring and grouping as hypothesised, e.g. with each NTS grouping into the five original NTS constructs of decision-making, leadership, situation awareness, team working and communications using a 5-point Likert-type scale.

The EFA indicated that on the basis of respondent perspectives the hypothesised five constructs could be reduced to three new constructs (Table 5). There was a clear alignment of sub-skills into the new factor structure, with the constructs characterised and named as personal effectiveness, assertiveness and self-awareness.

The scale used did exhibit number of limitations. The data suggested it was not measuring the NTS variables in the hypothesised groupings as identified by the experts from the NGT. A rhetorical question of 'did the experts get it wrong?' might be appropriate but the close alignment of the experts with published findings raises questions over this. The primary NTS used in stage two are cited in all the nine publications (see Appendix A2) which were used to aid the development of the NGT NTS taxonomy (HERIS) and are common to many domains and professions.

The five primary NTS (contained in HERIS) identified by the NGT experts were reducible to three new constructs using EFA. The survey demonstrated that using the three new constructs showed statistically significant improvement from t1 to t2, thereby indicating a development of NTS in participants which was the original primary objective, i.e. to determine the degree to which the simulation system (HEPE) developed NTS.

The three new constructs, when the types of sub-skill they encompassed were examined, were in a different permutation from the hypothesised NTS in HERIS (see Table 6). Vrindavan (2014) postulated that a person's

performance emerges from a combination of knowledge, skills and attitude. It is the interaction between the sub-skills that is significant. Marshalls (2015) asserts that this is a possibility. Her study, which was focussed solely on leadership state that '*the findings emphasised the influence of leaders` non-technical skills and personal characteristics in cooperation*' (Marshalls, 2015, p38).

A HEPE is a simulated environment which mimics a real incident and is designed to test plans, protocols, and processes and people's ability to respond in a real emergency. The research asked respondents about their confidence and ability to respond to a real emergency. Only 28% of respondents had ever responded to a real emergency before, so the potential to be able to project whether you consider you have the ability and confidence to respond effectively is insightful. The respondents' scores improved from 88% to 100% on ability and 70% to 96% on confidence. This is another indication of the utility of a simulation system (ETS, in this case) as a model of an exercise for individual NTS development by increasing confidence and recognising the ability to respond in an emergency. Even though the research was not designed to specifically validate ETS as a HEPE simulation system, the results do suggest that this simulation system had some success in fostering an increase in ability and confidence for participants to respond to a real emergency.

The survey included questions asking about the emergency response experience and the training respondents had received. Items were also included asking if respondents had responded to a real emergency previously or participated in an ETS before in order to explore the possibility that these elements may confer a difference (possibly advantage) in the development of their primary NTS to those who were new to the health emergency response. The results suggested that having been involved by role, training, response or participation in ETS showed no significant difference. This may indicate that all respondents would appear to benefit equally. It could also imply that even if you have participated in a simulation exercise such as ETS before you will still gain a benefit from doing these exercises multiple times.

NTS are difficult to measure and for a participant to interact with the survey, particularly one that was newly designed and where the survey would solely measure the five hypothesised NTS, was possibly unrealistic. The EFA indicated that the five NTS constructs could be reduced to three new factors captured using 13-point measure. The 13-point measure shows promise for development into fully developed scales. However, this stage lies outside of the scope of the thesis.

5.11 Chapter summary

This chapter articulated the stage two method and described the process of the stage through a series of iterative pilots to the main data collection phase. It provided a critical evaluation of the method selected and explained why this method was the preferred approach. This chapter also incorporated the analysis of the data collected and a discussion of the significance of the data.

The chapter identified the following key findings:

- Stage two looked for insight into a data collection method to enable the gathering of NHS personnel perspectives on the effectiveness of a simulation system (such as ETS, which was used as the intervention) in the development of NTSs from participation in a simulation exercise.

- After a critical review of the possible data collection methods available, an online survey (using SelectSurvey) was selected as the most appropriate approach to gain an insight into NTS development pre and post the simulation exercise intervention.

- The question set was mapped to HERIS from stage one and consisted of five primary NTS and each primary NTS had between four and five linked sub-skills. There were five phases of improvement on the survey conducted between Feb 2015 to Nov 2016.

- The main survey was conducted with *n*=266, Of these 266, 158 surveys were completed. Generating a sample of *n*=50 of completed pre and post surveys. This was the sample used for data analysis.

- Most respondents had an emergency role (68%) and half had been in the role for more than three years. 82% had received emergency response training. 64% of respondents had not participated in an ETS before.

- The comparative analysis indicated that a respondent's ability and confidence to respond increased from pre to post intervention. Confidence increased from 88% (pre-intervention) to 100% (post-intervention). 70% of respondents felt confident to respond to an emergency pre-intervention compared to 96% (post-intervention).

- Data analysis showed that overall, there was a significant difference between each pair of time points (t1 to t2) for four of the five primary NTS after participation in the simulation system used, equating to 92% of the items showing an increase.

- Using non-parametric testing showed there was an increase in all the NTS composite mean scores pre to post intervention which was consistent with the parametric testing.

- Previous experience (role in emergency response role/training/previous response to emergency or participated in ETS before) did not add significantly to the development of NTS in respondents as all gained participants equally.

- 48% of respondents considered the intervention as the mechanism for a developmental change to their NTS mean scores or had raised awareness of NTS they already possessed. This means at almost half the respondent were more enlightened about their NTS after the exercise which may suggest that it was worthwhile in highlighting NTS to respondents.

- Three new factor constructs were identified using EFA; these were personal effectiveness, assertiveness and self-awareness. The three new factor constructs had significant increased mean score when comparing pre to post the intervention construct mean scores.
- The five primary NTS (contained in HERIS) were reducible to three new constructs with different sub-skill permutations from the hypothesised NTS groupings (in HERIS).
- The EFA indicated that the five NTS constructs could be reduced to three new factors captured using 13-point measure. The 13-point measure shows promise for development into fully developed scales.

In the next chapter, the research data will be discussed, and wider inferences drawn from the overall analysis.

CHAPTER 6 - DISCUSSION

6.1 Introduction

This chapter explores the significance of the research and the wider inferences that can be drawn from the data analysis through a discussion of the results with reference to previous research. It provides context to the main themes identified within the literature review, which included the utility of HEPEs, NTS taxonomies and NTS in HEPEs and highlights key interpretations. The chapter draws out and elaborates the key points raised in the discussion sections of chapter's four and five. It concludes with a reflection upon the limitations of the research, unexpected findings and implications for future policy and practice.

The research aim: To examine the effectiveness of contemporary NHS health emergency preparedness exercises in enhancing the non-technical skills of health sector staff.

The research sought to examine current NHS HEPEs and how effective they were in aiding participants in developing their NTS. As Boyd et al., (2013) notes '*exercises are a major component of developing preparedness, but knowledge is lacking regarding their effectiveness*' (Boyd et al., 2013, p90).

None of the previous studies discussed in detail in Chapter 2, were focussed on the development of NTS through HEPEs. The research question posed was how effective are current NHS health emergency preparedness exercises in developing/enhancing non-technical skills of NHS personnel? Having first defined relevant NTSs, the effectiveness of the widely applied ETS emergency response simulation in enhancing participant NTSs was explored using a before and after design. The next sections discuss the results covering four key areas.

- The role and importance of NTS in emergency response
- The extent to which the experts NGT results mirror published findings
- Towards a model of NTSs

- Reflection of the contribution of ETS to NTS development

The discussion concludes with a reflection upon the key findings, implications for policy and practices, strengths and limitations of the study, and the scope for further research.

6.2 The role and importance of NTS to emergency response

NTS are recognised as important in emergency response to increase the effectiveness of responders. NTS have received notable attention, within HROs such as aviation and the nuclear industry (Crichton and Flin, 2004 and Baker et al., 2006). Similarly, they are accepted as important personal development skills for healthcare professionals working in all roles, in particular those that involve direct interaction with the public, (Yule et al., (2006) and Fletcher et al., (2003)) and high consequence team-working contexts such as operating theatres (Baker et al. 2006).

Key NTS for emergency responders in the health sector have not been clearly defined within contemporary published accounts, neither has the role of these NTS in helping personnel achieve enhanced competence in their technical skills. The literature review revealed a lack of authoritative literature on individual skills development from participation in emergency response exercises. However, there is notable consensus regarding the perspective that such exercises provide the only viable means to simulate a real event, while acknowledging that there are a number of limitations to their effectiveness including the claim of lack of realism.

6.2.1 Realism in exercise scenarios

> '*Organizations and experts use plans as forms of rhetoric, tools designed to convince audiences that they ought to believe what an organization says. In particular, some plans have so little instrumental utility in them that they warrant the label "fantasy document".*' (Clarke, 1999, p2)

At this point, a discussion on the 'unreality' of emergency response exercises is apt. Clarke (1999) notes the 'fantasy' of emergency planning of which exercising is one element (Clarke, 1999). He observes that organisations whose activities are prone be affected by large-scale disaster (which the NHS arguably is) have to engage in planning even if it is apparent that the planning for such events is an 'improbable' task. Riley et al., (2012) states that '*exercises can suffer from a lack of realism that reduces the value of the exercise in terms of the positive experience of the participant and the possibility that outcomes are based on artificialities created by the exercise environment. It is important to minimise these so that participants actively engage and recommendations are based on robust observations'* (Riley et al., 2012, p143).

Drabek and Hass (1967) discuss the relationship between realism versus artificiality (Drabek and Haas, 1967) and this is the challenge in emergency response exercises to provide a sufficient level of realism versus a degree of artificiality that is necessary to enable an exercise to progress and achieve its aim. Section 2.2 observes that activities and physical provisions such as actors playing casualties to add realism and authenticity are used routinely. However, people know fundamentally that they are not dealing with a real event and that there are no repercussions to the wider environment from their actions. As a consequence, some participants may not engage fully with the exercise. Cid (2017) claims that augmented and virtual reality can provide a higher level of realism (Cid, 2017) and thus have an edge on traditional exercises.

ETS was used as the intervention in this research and Rybing et al (2016) notes that ETS uses low-fidelity constituents that do not change over time such as patient states (Rybing et al., 2016). This can lead to a reduction in realism for the participant, as this places a heavier reliance on participants imagining the developing situation. However, this lack of variation does enable evaluators to assess the response during the simulation. ETS, while being adaptable to almost any scenario and setting, is not physically embedded within a hospital location and relies on participants cognitive ability

to use the logistical and process elements of the system to represent the incident and thus the response. As advocated in the literature review, role play in an emergency response exercise is important in the development of NTS (Crichton, 2001) and ETS uses an element of role-play to increase the benefit to participants.

The suggestion from this discussion indicates that exercise scenarios, although having limitations which would include a lack of realism, do provide a personal utility and that new technologies are bringing an increased level of participant realism not previously available.

6.3 The extent to which expert's NGT results mirror published findings

This section will compare the expert's NTS results with published material and the rationale for ranking the NTS and then discuss the degree of alignment between experts and participants.

NTS are difficult to measure since they are not directly observable like a technical skill, which tend to be more suited to measurement, e.g. the time taken to erect a decontamination tent. NTS must be inferred from a person's behaviour, or reflective subjective assessment or be assessed by others. As the literature review revealed no extant HEPE skills measurement tools were available (see Reedy et al., (2017)). One of the key research challenges, therefore, was developing a NTS measurement instrument that could be used in a HEPE. Stage one of the research focused on the creation of a taxonomy of NTS, based on expert judgement. The product of this was termed Health Emergency Response Integrated non-technical Skills or HERIS. HERIS was the culmination of the expert panel reflections using their knowledge and experience of their perceptions of key NTS in health emergency response. The experts identified five primary NTS they considered important in health emergency response: decision-making, leadership, situation awareness, communication and team working. The experts collectively ranked these skills using their experience from the most important to the least important NTS. The rationale for ranking the list rather than just capturing a list of NTS

was to enable a more meaningful comparison with the participants perspectives on relative importance of each NTS in emergency response. However, the output from the EFA does not offer any indication of relative importance.

The five skills identified by the experts reflect close alignment with previous NTS identified within the literature. The primary NTS that the experts chose from were derived from nine key category publications (see Appendix A2). These are numbered one to nine in appendix A2. These publications yielded 53 different NTS that were judged to have potential applicability to the health emergency response context. The experts were tasked with selecting and adapting these to focus on emergency response. It was clear from the nine key publications that they had all or some of the five primary NTS in common. The expert's selection showed strong alignment with the named NTS in publications 1, 4, 6 and 9 (Flin et al. (2002), Crichton and Flin (2004), Flin et al., (2006), Kodate et al., (2012)) in Appendix A2. Publication 5 (Crichton et al. 2005) had four NTS in common (it was missing communications NTS). Publication's 2, 3, 7 and 8 (Flin et al., (2003), Fletcher et al., (2003), Kim et al., (2006), Bonsall-Clarke (2008)) had three NTS in common with HERIS. To provide a viable comparison to the expert's ranking publications 1, 4, 6, and 9 (Flin et al. (2002), Crichton and Flin (2004), Flin et al., (2006), Kodate et al., (2012)), which had the greater alignment with the expert listing, was considered further. Publications 2, 3, 5, 7 and 8 (Flin et al., (2003), Fletcher et al., (2003), (Crichton et al. 2005), Kim et al., (2006), Bonsall-Clarke (2008)) had less commonality of NTS to enable worthwhile comparison.

The element that differentiated HERIS from the taxonomies compared in Appendix A2, was that HERIS was a ranked taxonomy, in that the expert panel were tasked not only with selecting and adapting relevant emergency response NTS but also to rank the NTS in order of importance. They did this using their expertise in the field of emergency response. This ranking enabled a comparison of the experts list to the participants perceptions of the relative importance of each NTS. Table 10 shows the NTS list for publications 1, 4, 6, and 9 along with HERIS. These publications were chosen as these

were the most closely aligned to the experts output (HERIS). Table 10 shows the listings for each publication as they appear in each paper.

Table 10. *A table showing comparative NTS ordered lists*

Publication 1 Crew resource management: improving teamwork in HROs	Publication 4 Identifying and training NTS of nuclear response teams	Publication 6 Development of a rating system for surgeons NTS	Publication 9 NTS for enhancing patient safety	HERIS Health Emergency Response Integrated non-technical Skills
Situation awareness	Decision-making	Situation awareness	Situation awareness	Decision-making
Decision-making	Communication	Decision-making	Decision-making	Leadership
Communication	Situation awareness	Leadership	Communication	Situation awareness
Team working	Team working	Communication	Team working	Communication
Leadership	Leadership	Team working	Leadership	Team working

According to the methodology defined in publications 1, 4, 6, and 9, they describe no discernible hierarchy of the NTS selected. Publication 6, Yule et al., (2006) did have a tri-level hierarchical format for the behavioural marker systems but not for the NTS. Each publication cited the same primary NTS but in differently ordered (not ranked) lists with no commonality between each other than having the same constituent NTSs. The publications do not give reasons for the order that the NTS were shown in the publications. It would appear from the publications, that the rank was not specifically considered in these studies. Table 10 shows that in publication 1, 4, 6 and 9, team working was always at position 4 or 5 and decision-making was always in position 1 or 2. This is consistent with the expert ranked listing. A comparison was then made between the experts' and participants' ranking of NTS.

HERIS provided the framework for stage two of the research by mapping a list of primary NTS deemed to be the most appropriate for health emergency response that could be applied to HEPEs. HERIS was used as the basis for the NTS measurement instrument used in the quantitative survey of the

participants of ETS. Table 11 contrasts the ranking produced by the NGT expert panel with the pre and post ETS participant responses.

Table 11. *A table showing primary NTS ranking by NGT and survey*

Ranking	NGT experts	Pre ETS	Post ETS
1	Decision-making	Communications	Communications,
2	Leadership	Situation awareness	Situation awareness
3	Situation awareness	Leadership	Decision-making
4	Communications	Decision-making	Leadership
5	Team working	Team working	Team working

Table 11 shows that the expert panel ranked decision-making as the principal skill required to respond effectively in an emergency. The ETS participants ranked communications as first both pre and post ETS. A common factor between the three sets of rankings was team working at number five, i.e. the lowest ranked item. The pre and post ETS participant rankings showed very little variability, with only leadership and decision-making changing pre to post ETS. The expert panel valued decision making and leadership over the other NTS, but participants ranked communications highest (pre and post). This may be due to the perspective that each was viewing this from. Experts by the nature of their inherent experience (most on the panel had over 10 years in-post experience) and insight may value decision making and leadership as they will have experienced real incidents and consider these as advantageous NTS in a real response (Hosseini and Izadkhah, 2010). Whereas 75% percent of the participants were relatively new to emergency response (less than 5 years) and only 28% had ever responded to a real emergency and of those most had only experienced one. These participants may view the NTS of communications more highly as possibly they would need to interact and communicate more intensively to enable them to respond more effectively due to their lack of experience or it could be an artefact of ETS that people needed to communicate due to the artificiality of the simulation and thus regarded this NTS more highly.

This discussion has recognised the connection between the five primary NTS established by the NGT experts and the links to previous research and a comparison to the participant NTS rankings.

In addition to the five primary NTS, the expert panel identified a series of NTS sub-skills associated with each primary NTS (Table 1 - HERIS). It is these sub-skills that differentiate health emergency response from other domains and professions and other taxonomies mentioned in Appendix A2. This presents as a notable difference from previous research. For instance, Appendix A2 publication 1 (Flin et al., 2002) targeted at HROs, cites a sub-skill targeted at plant status awareness. This shows a level of focus on the specifics of HROs. Each NTS contained in HERIS is specific to health emergency response as determined by the expert panel who identified the wording appropriate to each sub-skill and it is the sub-skill descriptors that differ. These sub-skill descriptors are different and original and are directly relevant to health emergency response as they are targeted and bespoke.

Appendix A3 shows the original sub-skill descriptors that the experts used as a starting point and then derived their description from for HERIS. This appendix shows each of the 53 skills and was allocated a number between 1 and 53. When examining the composition of each NTS sub-skill descriptors contained in HERIS, the following may be inferred:

- Decision making NTS was principally decision-making and action (skill no. 20) (Bonsall-Clarke, 2008) with a contribution from decision-making (skill no. 18), which came from the NGT pilot expert panel. The principal NGT expert panel added the element to ‘log and document’. This made the overall sub-skill descriptor original when compared to previous research.

- The leadership NTS was an amalgamation of Leadership (skill no. 23 and 25) with a core of leadership (no. 26) which again came from the NGT pilot expert panel and Leadership (skill no. 27) (Kodate et al.,

2012). The principal NGT panel amalgamated the four descriptors to make this NTS bespoke to health emergency response. This made the sub-skill descriptor original when compared to previous research.

- Situation awareness NTS was principally situation awareness (skill no. 38) (Yule et al., 2006) but there was a significant agreement with the other situation awareness descriptors with regard to gathering and understanding information. The principal NGT expert panel added the element to 'reassess and reject' as an original input. This made the sub-skill descriptor original when compared to previous research.

- The communication NTS sub-skill descriptor was split between communication (skill no. 6) (pilot NGT) and Communications skills (skill no. 8) (Kodate et al. 2012). The combination was original when compared to previous research.

- The teamworking NTS was principally Team working (skill no. 50) (Fletcher et al. 2003) with a contribution from Team working (skill no. 49) (Flin et al. 2002). The combination was original when compared to previous research.

It can be concluded from the discussion above that HERIS and its five original sub-skill descriptors were a combination of 11 previously described sub-skills from a range of domains and professions including rail industry (decision making), surgery (situation awareness), patient safety (communication) and anaesthetists (team working). Leadership was spread broadly across several domains including the oil industry, critical care and patient safety with a contribution from the principal NGT expert panel who added original content and amalgamated descriptors where appropriate.

From the discussion above it can be reasoned that HERIS although heavily influenced by previous research and taxonomies was developed and bespoke to health emergency response.

6.4 Towards a model of NTS

In working towards a model of the NTS, the questionnaire was developed to collect NHS personnel perspectives of the effectiveness of HEPEs as a way to develop NTS (using ETS). The questionnaire went through a series of iterative versions and was designed to reflect the hypothesised constructs of decision-making, leadership, situation awareness, communication and team working which were considered important in health emergency response. The output from the survey was subjected to an EFA to explore the statistical relatedness of responses. Findings revealed that the data could be characterised as grouping around three new factors. These were then refined through item analysis to produce a set of three scales. This process of data analysis indicated that NTS could be characterised: personal effectiveness, assertiveness and self-awareness. Each factor had been identified within previous research, see (Bandura, 2009), (Flin et al., 2002), (Pearsall, 2006), (Flowerdew, Brown, Vincent, et al., 2012), (Robertson et al., 2014), (Malec et al., 2007), (Jain and Anjuman, 2013), (Salas et al., 2001), (Crichton et al., 2005) and (Bonsall-Clarke, 2008).

The titles of the factors are not commonly encountered as primary NTS descriptors such as those in Table 10, but there is a precedent in previous publications:

- Personal effectiveness – Bandura (2009) mentioned personal efficacy, sometimes describes as personal resources (Flin et al. 2002). Bandura notes that '*among the mechanisms of self-influence, none is more focal or pervading than belief in one's personal efficacy'* (Bandura 2009).

- Assertive(ness) – examples include: Pearsall, (2006) discusses assertiveness on team performance; Flowerdew, Brown, Vincent, et al. (2012) identifies assertiveness as a specific NTS for safety within an emergency department; Robertson et al., (2014) includes assertiveness as part of leadership NTS for operating theatre teams and Malec et al., (2007) include assertiveness as part of leadership primary NTS.

- Self-awareness – Jain and Anjuman, (2013) recognise self-awareness as a distinct management skill; (Salas et al. 2001) recognise self-awareness as part of CRM; Crichton, Lauche and Flin (2005) noted self-awareness as a characteristic of team leaders in the oil industry. The NTS is also closely aligned to self-management (Bonsall-Clarke, 2008).

Although the expert panel did not identify the constructs of personal effectiveness, assertiveness and self-awareness, Appendix A2 does indicate that these constructs were identified and supported by previous research in the areas of high reliability organisations such as nuclear response teams, surgeons NTS and enhancing patient safety. Using effectiveness, assertiveness and awareness as sub-skill key words, these sub-skills are mentioned 16 times (effectiveness (3), assertiveness (6) and awareness (7)) within other key publications (see appendix A2). This would indicate that the factors are aligned with previous findings and are feasible constructs.

The significance of this section of discussion is that although the EFA data analysis identified three new factors, instead of the original five hypothesized groupings, there was a closer alignment of the perceptions of the expert panel with published findings captured in HERIS than with the new factors. However, the fact that the EFA reduced the groupings from five to three to reflects a smaller number of deeper latent constructs, which is considered a strength. The five constructs were the initial ‘best guess’ using five scales. The EFA was then used to test the hypothesis and the correlations between the responses to the questions, which grouped to form three clusters (not five). This statistical relationship was more robust than the initial best guess. Further, following the rule of parsimony, in that a system should contain the minimum number of constructs/factors, see Flin et al., (2003) and (O’Connor et al. 2002), the reduction from five constructs to three factors is considered a positive outcome.

6.5 Reflection of the contribution of ETS to NTS development

An acceptance of the benefit of emergency preparedness exercises to participants, in particular, NTS development for health personnel taking part in HEPEs, is not robustly supported within the literature and there is a need for data to support or refute a conferred benefit. This research does provide a level of empirical evidence supporting the general acceptance of a benefit to individuals and is consistent with Skryabina et al. (2016). These authors notedsthat '*Health emergency preparedness exercises were found to be effective (post exercise) at improving participants' knowledge of emergency activities, policies and procedures and improving overall competence and confidence*' (Skryabina et al., 2016, p274).

The literature review highlighted that HEPEs are generally designed to test not train at the organisational level. Reedy et al. (2017) notes that emergency preparedness exercises are sometimes used to develop technical skills in individuals. The literature review comments that exercises are intended as a means to test and validate, they are sometimes used as a training opportunity due to lack of resource or little or no previous training being conducted. It would be reasonable to suggest, based on the evidence of the literature review, that generally emergency preparedness exercises are not explicitly designed to develop primary NTS. The quantitative results suggested that the intervention was able to achieve/recognise a level of primary NTS development in 48% of respondents.

The results suggest that participants reflected that the simulation system (ETS) enabled them to develop their NTS through participation in the HEPE. This is supported by the EFA constructs pre to post results showing an increase in NTS score.

The results of this research are consistent with the contemporary empirical studies Sarpy et al. (2005); Bartley et al. (2008); Savoia et al. (2009); Kotora et al. (2014) and Gordon et al. (2015) that have given quantitative outcomes for individuals from emergency response related studies. The previous

studies indicated a level of individual benefit and reported a positive individual outcome. This research aligned to those studies with statistically significant results for the development of individual primary NTS. Overall, it may be reasonable to state that the quantitative survey analysis indicated the utility of the ETS intervention to support the development of primary NTS.

The preceding discussion suggested that the literature indicates that exercises rarely overtly target NTS development. The research explored the degree to which the elements of ETS had a positive impact on participants' NTS. The data strengthens the hypothesis that NTSs were enhanced via participation in the intervention. This was validated by the increase pre to post ETS for the new factor constructs; each showing post-hoc higher ratings (personal effectiveness and assertiveness had significant p values of $p<0.001$ and self-awareness was $p = .002$).

6.6 Reflection on the methods selected and scope for enhancement

Overall, the research design was considered appropriate to answer the research question posed and achieve the aim. The aim was exploring the effectiveness of health emergency preparedness exercises and, using quantitative methods, indicate a numerical value to changes from pre to post intervention. However, a focus on the qualitative rather than quantitative nature of NTS may have yielded a more elucidatory set of results, as a numerical value is a small part of a complex set of interactions that represent NTS in emergency response exercises. This could be achieved with the use of observational methods, see Fletcher et al., (2002). These authors note that '*observational studies allow behaviour to be examined under all conditions, both in the real operating environment and in the simulator. This can provide information about what is going on when things go well, what prevents everyday difficulties from leading to more serious problems, how different groups of people perform differently* (Fletcher et al., 2002, p420). NTS by the nature of being difficult to measure (Borodzicz and Haperen, 2002) may have benefited from this more descriptive and qualitative approach because how do you quantify such entities?

As part of the iterative process employed in the research, the survey response scale was increased from four to five (a five anchor Likert scale is commonly used). This improvement increased the variability of responses and indicated a modest increase in the spread of scores (using the 5-point Likert scale) for questions in the survey compared to the pilot survey using the four-point scale. However, this was marginal as the median was still four for most of the questions. Many respondents viewed their NTS in the upper percentiles of the 5-point Likert scale both before and after the intervention. The Likert scale used in the main survey requires more development to increase its sensitivity. However, the 13-item measure developed from the EFA, does show promise for further development and should be explored further.

6.7 Limitations of the research

One limitation of this study was a specific focus on ETS as a representative HEPE. This precluded comment on other types exercise and system as a conduit for NTS development that are available and used for emergency preparedness as they were not utilised. This may have given an inadvertent bias to this system. It is conceivable that other traditional exercises may also have yielded similar results. The rationale for selecting ETS was that it was representative of a contemporary HEPE used by the NHS; was readily available to the researcher and provided and a repeatable, controlled and safe environment.

A further limitation was the development of the NTS question set that was used in the survey in study two as there were no extant scales to use (Reedy et al., 2017). This was problematic as there was not a current validated scale appropriate to this research. The challenge was then to either adapt an existing questionnaire, which may not have the exact items required (Hyman et al., 2006) or develop a new scale that was psychometrically sound, efficient and effective for use in the research (Tsang et al., 2017). This was addressed by developing a new NTS measurement instrument. Stage one of the research enabled the creation of a ranked taxonomy of NTS, based on expert judgement, and was named Health Emergency Response Integrated non-technical Skills or HERIS. HERIS provided a framework for stage two by

providing a list of the primary NTS most appropriate for health emergency response that could be applied to HEPEs and developed into a viable scale. It was important that the questions used in the survey had high face validity and produced reliable and stable data. A cognitive pilot addressed issues of face validity, ambiguity and drafting errors for the questions. Further spurious and irrelevant questions were removed during the piloting phases as per the method described in section 5.3.3. This constrained the limitations of the lack of an extant scale. In addition, the development and deployment of an extended scale with an anchored measurement scale appended to agree/disagree questions in the survey should be considered (a small extension from five to seven anchors). This may provide respondents with the opportunity to make selections from a wider choice of responses. A semantic differential scale could be considered which measures attitudes towards 'something'. Although Birkett (2019) postulates that '*the more quantifiable the information is (behaviour questions for instance), the smaller the range should be'* (Birkett, 2019). The additional of two extra anchors may improve the modest variance and notable skew of the observed data.

6.8 Unexpected research findings

The survey included questions about the emergency response experience and training. Questions also asked if respondents had responded to a real emergency or previously participated in an ETS to explore the possibility that these elements may confer a difference (possibly advantage) in the development of their NTS compared to those who were new to health emergency response. The results suggested that having been involved by role, training, response or ETS participation showed no significant difference. None of the three new constructs showed significant *p* values. This may indicate that all respondents would appear to benefit equally. Experience does not aid in the development of primary NTS. It might also imply that even when personnel have participated in an ETS previously they may still gain benefit from doing a simulation exercise multiple times. This would appear to contradict a common-sense view that the more experience you have of a role

or activity the better you would reasonably become. However, this may be an artefact of participation in an emergency preparedness exercise.

6.9 Implications for future policy and practice

This research forms an evidentiary basis to apply to future health emergency response exercises and has implications for future policy and practice. While these are limited, the study indicates that more focus should be given to the development of NTS in NHS personnel in emergency response in the same way it has been recognised in other areas of healthcare such as anaesthesia and surgery. This will require additional resource to first research and then apply the research to aid the attainment of NTS in NHS personnel.

More specifically, the research suggests that more targeting of the communication NTS for health emergency responders will be beneficial (Akbar, 2014), section 7.7 outlines the possibilities.

6.10 Chapter summary

This chapter summarised the overall thesis discussion. As stated in the introduction, confidence remains vested in the effectiveness of experiential development presumed to arise from participation in emergency preparedness exercises. The results of the study are noteworthy as they provide a level of empirical evidence not previously available on the primary NTS development in HEPEs. This impacts our understanding of the problem presented in the introduction. The data from this research may now make it reasonable to agree with previous publications acceptance of the development that emergency preparedness exercises provide a positive experiential experience that leads to the development of person's NTS.

This chapter provided a discussion of the research; integrating the analysis presented in chapters four and five, and identified the following key findings:

- The results of this research are consistent with the contemporary empirical studies that have provided quantitative outcomes reporting a

positive individual benefit for individuals from emergency response related exercises.

- NTS are recognised as important in emergency response to increase the effectiveness of the responders (Crichton and Flin, (2004) and Baker et al., (2006)).

- Key NTS for emergency responders in health emergency response is not clearly documented in current literature. The discussion recognised the connection between the five primary NTS (characterised in HERIS) established by the NGT experts and the links to previous research.

- The discussion reasoned that HERIS and its component five original NTS sub-skill descriptors, although heavily influenced by previous research and taxonomies, was bespoke to health emergency response.

- The EFA data analysis identified three new factors. The discussion postulated that the survey was, in addition to applying a quantifying element to the selected primary NTS, had indicated the existence of three new factor NTS constructs characterised as personal effectiveness, assertiveness and self-awareness using a 13-point measure.

- The three new factors EFA constructs had an increased mean score when comparing pre to post ETS (personal effectiveness and assertiveness had significant p values of $p<0.001$ and self-awareness was $p=.002$). The new factors would warrant further exploration.

- The discussion noted from current literature, that exercises rarely overtly target NTS development. The results strengthen the hypothesis that NTSs were enhanced via participation in the ETS intervention.

- NTS by the nature of being difficult to measure (Borodzicz and Haperen, 2002) may have benefitted from this more descriptive and qualitative approach and it may be logical to consider a focus on the qualitative rather than quantitative nature of NTS to possibly yield a more elucidatory set of results in future research.

- There were no extant scales to use (Reedy et al., 2017). The 21-point measure developed for the study, (subsequently reduced a 13-point measure via EFA) did exhibit limitations as analysis suggested the scale was not measuring the NTS variables as part of the hypothesised groupings. The survey requires more development to increase its sensitivity.

- Unexpectedly, the results suggested that previous experience such as having an emergency response role or having been involved in an emergency response showed no significant difference in the development of primary NTS for those with no experience. This may indicate that all respondents would appear to benefit equally.

- The study indicates that more focus should be given to the development of NTS in NHS personnel in emergency response in the line with other areas of healthcare such as anaesthesia and surgery.

The next chapter provides a conclusion to the research.

CHAPTER 7 - CONCLUSION

7.1 Introduction

This chapter presents the conclusion to the thesis. It includes a link back to the introduction via Perry and a summary of key aspects of each chapter with an overview of the main elements of the research. There is a concluding statement outlining the contributions of the research and a section on the potential contribution to emergency planning practice and policy. The chapter also includes suggestions for future research and recommendations with practical implications of the thesis findings.

7.2 Bringing it back to Perry

The thesis began with Ronald Perry's observation that emergency preparedness exercises deliver a variety of benefits, but as this thesis has shown, there have been few empirical studies exploring effects on participants. The research reported in this thesis is intended to make a contribution to filling this evidence gap by adding to the valuable input and influence by authors in this field, such as Rhona Flin and Margaret Crichton.

7.3 Overview of the main elements of the research

This section summarises the key findings from the study.

The thesis started by establishing an overview of the research to provide the context and background to the study.

The literature review, revealed a comprehensive array of publications on the utility of emergency preparedness exercises, non-technical skills development and measurement, from emergency preparedness/response research and relevant complementary sources, such as surgery, anaesthesia and aviation.
The review revealed a number authors laying claim to the benefits of simulation exercises, notably Agboola et al. (2013), Savoia et al. (2009), Riley et al. (2012), Peterson and Perry (1999), Borodzicz and van Haperen (2002)

and Perry, (2004), as well as a number of detractors, e.g. Bartley et al. (2006) and Ford and Schmidt (2000).

The review concluded that there was a notable consensus that emergency preparedness exercises provide a viable means to simulate real events (Borodzicz and van Haperen, 2002). Most publications hold that there is benefit in participating in exercises, while acknowledging that there are limitations to the conduct of emergency preparedness exercises. The review sponsored the conclusion that ETS, like most simulations systems, has limitations but does include a key element of role play which has been shown to aid in the development of NTS (Crichton et al, 2001).

Influential contemporary perspectives on NTS development can be traced to foundation work in aviation on Crew Resource Management (CRM), see in particular contributions from Flin (2001, 2002, 2003, 2006, 2007 and 2015) and Crichton (2001, 2004 and 2005).

The literature review led to nine key publications being selected to inform the research. Through these, a number of NTS taxonomies were identified. The publications yielded an extensive list of 53 primary NTS skills. In addition, six previous research studies were selected to provide context to this research.

A significant challenge for the research was finding a reliable measure for NTS (in HEPEs), as research had indicated that there were no NTS measurement tools available with demonstrable reliability (Reedy et al., (2017).

Conventional research paradigms were considered for the study including positivism, interpretivism, objectivism and constructivism. However, the literature suggested a mixed methods approach may be of better fit with the phenomena of interest and the aims of the study. Reflecting alignment with the pragmatic paradigm, a mixed (quantitative and qualitative) approach was therefore adopted. Having selected a mixed method approach, alternative data collection methods were considered. The relative strengths and

limitations of alternatives were assessed. Focus groups and a social survey were selected as the primary data collections methods.

The NGT technique tapped into the experience of a panel of healthcare emergency responders and members of the UK faculty for ETS experts proved effective in developing a taxonomy of five primary NTS for health emergency responders. This taxonomy was subsequently characterised as the Health Emergency Response Integrated non-technical Skills (HERIS) as shown in Table 12.

Table 12. *Health Emergency Response Integrated non-technical Skills (HERIS)*

Rank	Skill	Sub-skill descriptors
1	Decision-making	The ability to make a timely decision; clear and decisive; recognise the implications of your actions on yourself and others; accountability of decisions taken; log and document.
2	Leadership	The ability to motivate people to perform and follow your direction; inspire confidence and keep perspective; communicate with others. Manage workload and resources; plan and prioritise.
3	Situation awareness	The ability to gather and understand information; confidence to consider, reassess and reject options. Projecting and anticipating future state.
4	Communication	The ability to communicate efficiently, effectively and in a timely manner with all levels (internal, external, individuals and groups). Clarity of information including context and intent; identifying and tackling barriers to communication.
5	Team working	The ability to coordinate activities and exchange information; supporting others. Use authority and assertiveness; maintain team focus.

There was congruence between the primary NTS contained in HERIS and other NTS taxonomies in contemporary literature, but the sub-skills in HERIS are original. They were developed and honed by the NGT experts so as to be applicable to health emergency response.

Stage two of the research used a survey and looked for insight into NHS personnel's perspectives on the effectiveness of the ETS simulation system in developing participant NTSs. A pre and post design provided an indication of the added value attributable to participation in the ETS exercise. The question set was mapped to HERIS and consisted of five primary NTS, each composed of between four and five linked sub-skills.

The pre-post evaluation survey was distributed to 266 participants, 50 of whom completed both the pre and post surveys.

A comparative analysis indicated that a respondent's ability and confidence to respond in an emergency situation increased post intervention, after receiving the ETS training, rising from 88% to 100% on ability and 70% to 96% on confidence (pre to post intervention). However, this analysis is weighted against the possible bias of participants being expected to improve; the researcher asking these questions (as discussed in section 4.4.1) and the influence of the hierarchical nature of the NHS system expecting this outcome.

Statistical testing revealed there was a significant difference between time points (t1 to t2) for four of the five primary NTS after participation in the simulation system. Participants' previous experience (role in emergency response role/training/previous response to emergency or participated in ETS before) did not add significantly to the rating of NTS status. Almost half the respondents scored their NTS more positively after the exercise.

The discussion suggested that the survey had captured a quantifiable element of the selected primary NTS and in addition indicated the existence of three deeper NTS constructs. These were characterised; as personal effectiveness, assertiveness and self-awareness. Use of these indices to compare pre and post ETS ratings indicated an improvement on each factor (personal effectiveness and assertiveness $p<0.001$ and self-awareness $p=.002$). The new factors would warrant further exploration.

The research made a case to agree with previous publications acceptance of the benefit that emergency preparedness exercises provides. The results of this research are consistent with published empirical studies. These contemporary studies have presented both a quantitative outcome and reported a positive individual benefit.

7.4 Theoretical contributions to practice and policy

Given the immaturity of research in the development of NTSs in HEPEs, the derivation of new constructs was considered feasible, as there was scope to enhance understanding and practice in relation to NTS development in health emergency response. While reflecting alignment with related studies, the approach adopted in this research had not previously been used within the health emergency response context. This approach aimed to make a contribution to filling an evidence gap cited by previous authors on the variety of benefits HEPEs confer.

The research sought to characterise core NTS in HEPEs, which was achieved through stage one, and developed into a NTS measure in stage two. Stage one substantiated findings from the literature in identifying a taxonomy of NTS that were interpretable in light of published findings but was structured and relevant to the specifics of this study, when compared to other domains such as aviation and other HROs. Stage two further improved understanding of individuals' NTS development of participants in ETS events and the EFA analysis indicating three deeper related constructs relevant to health emergency response.

This research presents an evidentiary basis to apply to policy and practice. The study indicates that more prominence should be given to NTS development of NHS personnel in emergency preparedness activities as has been recognised in other healthcare disciplines including surgical and anaesthesia teams.

7.5 Contribution of the research to science

This study provided empirical evidence that was not previously available on NTS development in HEPEs. There were three key outputs from the research. These were:

1. The development of a taxonomy of primary NTS for HEPEs called Health Emergency Response Integrated non-technical Skills' (HERIS). This built upon the previous research (as outlined in section 2.5.1) to develop and refine a NTS taxonomy with primary NTS and associated targeted sub-skills for health emergency response. The sub-skill element of HERIS is original.

2. The research revealed a significant difference (92% of the paired t-tests results showed an increased mean score from pre to post intervention) indicating a positive impact upon NTS development of individuals that participated in the simulation exercise. Although pre and post surveys have been conducted previously, this research used a HEPE (ETS simulation system) specifically targeted at healthcare professionals who were fulfilling an emergency response role. These results are original in nature.

3. There were three clearly delineated new factor constructs identified using EFA in a 13-item measure. These were characterised as personal effectiveness, assertiveness and self-awareness. These constructs revealed a significant difference in mean scores (pre and post intervention) indicating a positive impact upon NTS of participants. This measure shows promise for future development.

7.6 Realisation of the research aim

The aim of the research was to examine the effectiveness of contemporary HEPEs in enhancing the NTS of NHS personnel. A mixed methods approach was adopted. Using only qualitative or quantitative methods was considered too restrictive and not likely to provide the level of insight required. The

approach adopted made it possible to; critically review the literature; analyse the data effectively; develop a prototype NTS taxonomy; and extrapolate the NTS development in ETS participants to achieve the research aim.

Through this mixed methods approach, it was possible to provide an answer to the research question. The question asked, *how effective are health emergency responses exercises in developing NTS of NHS personnel?* Based on the data collected, it is possible to say that HEPEs do provide a level of development of NTS in participating NHS personnel. The results indicated that HEPEs (using the ETS intervention) do aid in the development of NTS.

7.7 Research recommendations

The following recommendations are advanced on the basis of the research findings:

- Recommendation one – Review of ETS exercise system to aid the augmentation of individual primary NTS development

The research explored the degree to which the elements of ETS had a positive impact on participants' NTS. The data strengthens the hypothesis that NTSs were enhanced via participation in the intervention. This recommendation, although targeted at ETS, is relevant to HEPEs in a broader context.

Participants' scoring for communication NTS did not show significant difference pre to post intervention unlike the other four primary NTS of situation awareness, decision-making, team working and leadership, that all showed a significant increase. This would indicate that this NTS was not significantly developed in the ETS intervention, even though it was ranked as the number one skill used by participants. In addition, the respondents also suggested that they perceived the NTS of situation

awareness was not used in the ETS, although the data suggested this was not the case.

To exploit the ETS simulation system and increase the potential to enhance the participant experience, a review could be considered of the delivery of this system. Achieving effective communication NTS and situation awareness enhancement would be a key focus. ETS could be developed by the addition of elements specifically designed to increase the potential for communication and situation awareness NTS enhancement to be directly developed. These could include a specific communication aspect of the exercise; such as assessing how a specific piece of information is communicated, and how participants communicate with each other. Participants could be asked about situation awareness at the end of the exercise; such as asking them to describe their perspective of the current emergency situation. This would provide an opportunity to reflect on what they have absorbed and compare their perspective to the 'known' exercise situation. As noted by Skryabina et al. (2016) '*despite the lack of evidence these* [emergency response] *exercises hold tremendous benefits for individual participants, and that exploring these should be a prime part of research in the field moving forward'*.

- Recommendation two – Explore the role of NTS in health emergency response

NTS are recognised as important in emergency response to increase the effectiveness of responders. They are accepted as important personal development skills for healthcare professionals (Yule et al., (2006) and Fletcher et al., (2003)). This research indicated that key NTS for emergency responders in the health sector have not been clearly defined within contemporary published accounts. This research (via HERIS) provides a taxonomy to define the skills relevant to the domain of health emergency response. However, understanding the role NTS health emergency response and that of an individual's NTS and how

they interplay between each other should be explored further. This could be achieved through socialising HERIS with a larger cadre of healthcare professionals and additional research such as observational studies as outline in 7.8.

7.8 Suggestions for further research

The study provides opportunities for further research that would complement this original study. The suggestions outlined below would take the research outcomes forward and could aid in the development of the HEPEs and simulations system such as ETS to increase individual development and aid understanding of the role of NTS in health emergency response.

- Suggestion one – Develop behavioural markers for the three new NTS constructs

  As Jenkins (2015) notes '*it can be deduced that a good assessment of non-technical skills requires consistent and insightful interpretation of behaviour, and this in turn requires the development of behavioural markers that are clear and consistent*' (Jenkins, 2015, p898). The measure used in this research could be improved with the development of relevant behavioural markers for each of the three new constructs. Yule et al. (2006) explained that behavioural marker systems tend to comprise of two parts: a skill taxonomy (developed in stage one), with a set of behavioural markers allied to each skill; and a rating system (to be developed in future research). The marker system could include examples of effective and ineffective behaviours as cited by Flin et al. (2003). This would work in conjunction with development of the 13-point measure. Due to the scope and scale of a Professional Doctorate, this was not possible within the time and funding constraints, but this suggestion could increase the robustness of future studies.

- Suggestion two – An additional study using observational methods to collect data on people's behaviours during an ETS simulation exercise

Kodate et al. (2012) notes that '*non-technical skills are not always directly observable and particularly in the case of cognitive skills, must be inferred from people's behaviour*' (Kodate et al., 2012, p362). A future study to allow a more in-depth insight into the behaviours of persons in a health emergency response environment. This could be conducted over two or more events.

7.9 Personal reflection on the research journey

The PD thesis journey has been a long one, which was at times, extremely challenging. To maintain a project's continuity for seven years and your enthusiasm, as well as a grip on all the moving parts of the project was extremely complex. It was only possible by breaking down the overall activity into manageable segments. I was far outside my comfort zone at times, which is good and bad in equal measure. One area of achievement which I was particularly proud of was the time I spent analysing the data and getting to grips with SPSS. SPSS was quite literally a different language and I had to expend a lot of time understanding statistics and how to use SPSS and more challengingly interpreting the results. This would not have been possible without constant and patient tutoring from Debbie Roy. She enabled me to standardise the quality of the result and present the data in a logical and comprehensible manner. I have a feeling that what took me six months to achieve she could have done in a couple of weeks due to her considerable experience.

I have previously completed a Master's level dissertation, but this project was another level of intensity and enabled the development of a whole series of in-depth project management skills and a review of the research methods available in a logical and dispassionate way. My academic writing has had to develop into a more discursive style and overall my analytical skills have

developed. I was determined that I would use all the technology available to help me to accomplish this project and referencing was a key area that technology could be applied. I used Mendeley, this was an excellent tool. Remembering my experience in my Master's and the time it took me to keep my references in order, using Mendeley was one of the areas of improvement that I realised over the course of this research.

This project was a test of all the expected elements of academic work to complete a project at this level but above all was a measure of personal tenacity and persistence. If there was an extant measure, I think I may have scored relatively highly on this scale. I have a full time demanding job and finding sufficient head space to complete this part time in what free time I had was the most challenging element. I learned to break the project into smaller more manageable tasks and to just keep going, and telling myself '*you will get there in the end'*, especially with the great support network I was privileged to have with me including my academic supervisor Andy Weyman, my practice-based supervisor Gabriel Reedy and Charles Turner at PHE who all provided much needed support.

7.10 Chapter summary

This chapter summarised the thesis, linking the introduction to the conclusion via Perry and provided a concise statement on the contributions of the research.

The literature suggested that developing individuals' NTS are held to be important in a range of domains. The research was conducted in two stages; a NGT followed by a survey. The NGT produced a prototype NTS taxonomy called HERIS. HERIS was then used in the stage two survey. The stage two survey indicated that simulation exercises (using ETS as the intervention) aided the development of selected NTS with 92% of the paired t-tests results showing an increase in mean score from pre to post intervention.

Three new clearly delineated new factor constructs identified using EFA also showed a significant difference in mean scores (personal effectiveness and assertiveness had significant p values of $p<0.001$ and self-awareness was $p=.002$). The 13-point measure shows promise for future development.

The chapter highlighted a series of recommendations for further work on developing ETS and understanding the role of NTS in health emergency response in healthcare. There were also suggestions for further research including the development of behavioural markers and data collection using observational methods.

Based on the research presented in this thesis, it is possible to say that the research question asking '*how effective are current NHS health emergency preparedness exercises in developing/enhancing the non-technical skills of NHS personnel?* was answered; the research suggests HEPEs do impart a level of development of specific NTS (decision-making, leadership, situation awareness, communication and team working) in NHS personnel participating in ETS exercises. Further, the research provided original findings that were not available before this research was conducted. This research provides a platform for further work to continue where this examination concluded.

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APPENDIX A

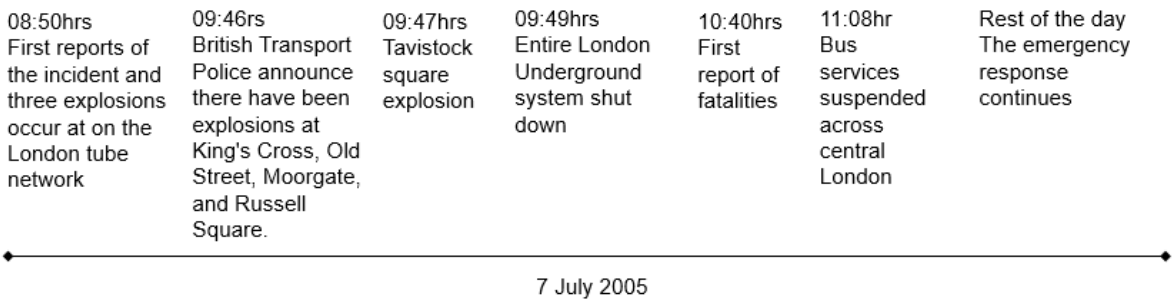
A1. Disaster case studies

Case study #1 – The 2005 London bombings

Introduction

The 7 July 2005 London bombings, often referred to as 7/7, were a series of coordinated terrorist suicide attacks in London, England, that targeted commuters travelling on the city's public transport system. Four bombers separately detonated homemade bombs in quick succession aboard London Underground trains and later, a fourth on a bus in Tavistock Square. The train bombings occurred on the Circle line near Aldgate, at Edgware Road, and on the Piccadilly line near Russell Square. 52 UK residents of 18 different nationalities, were killed, and more than 700 were injured in the attacks.

Timeline (7 July 2005)



Key publications

1. Coroner's Inquests into the London bombings of 7 July 2005: Review of progress (HM Government, 2012)
2. Report of the 7 July Review Committee (London Assembly, 2006)

Outcome/improvements

The report of the July 7th Review Committee (2006) report identified 54 recommendations and concluded that overall London's emergency plans should be reviewed to account for the needs of the individuals and that there was an urgent need to put in place plans to support those who are bereaved, and those who survive.

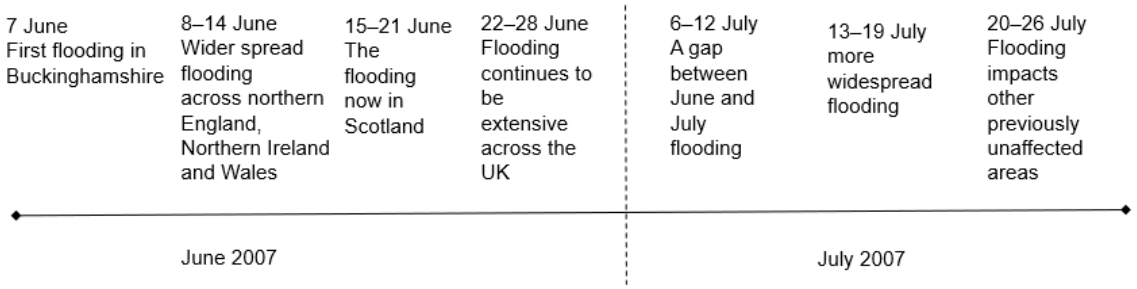
Lady Justice Hallett issued a report (Coroner's Inquests into the London bombings of 7 July 2005: Review of progress (2012)) providing nine recommendations. Key among the recommendations were that major incident training should be reviewed for all frontline staff, especially those working on the London underground; that a common initial rendezvous point is permanently staffed and advised to emergency services; a review training of London Ambulance Service (LAS) staff for 'multi-casualty triage'; and a review of the capability and funding of emergency medical care in the city.

Case study #2 – The 2007 UK summer floods

Introduction

A series of large-scale flooding events occurred in parts of the United Kingdom during the summer of 2007. June was one of the wettest months on record in Britain with an average rainfall across the country of 140 mm, more than double the June average and it was Britain's wettest May–July period since records began in 1776. The worst of the flooding occurred across Scotland (14 June), East Yorkshire and the Midlands (15 June), Yorkshire, the Midlands, Gloucestershire, Herefordshire and Worcestershire (25 June), and Gloucestershire, Herefordshire, Worcestershire, Oxfordshire, Berkshire and South Wales on (28 July). The Environment Agency stated that a total of 56,000 homes and businesses were flooded over the summer of 2007.

Timeline (June 2007 – July 2007)



Key publications

1. Review of 2007 summer floods (Environment Agency, 2007)
2. The Pitt Review: Lessons learned from the 2007 floods (Pitt, 2008)

Outcome/improvements

In 2007, the Environment Agency, as the lead agency, reviewed the response covering a strategic overview of inland flooding, critical infrastructure, flood risk management investment and incident response. The agency produced a 33-recommendation report targeting the government and their own response. They concluded that multi-agency incident response plans needed to consider the possible impact on critical infrastructure more effectively. Overall, the agency stated that a framework was needed to manage flood risk from all inland sources.

After this review, Sir Michael Pitt conducted a more extensive review of the lessons to be learned. The report contained 92 recommendations for a range of responder organisations and interested parties. His 505-page report highlighted an urgent and fundamental change to the way the UK is adapting to the possibility of more frequent and intense periods of heavy rainfall. The commission published an interim report (2007) of 15 urgent recommendations that required attention and the final report assessed that strong progress had been made to address some of these areas, but that critical infrastructure and public awareness recommendations still required more work.

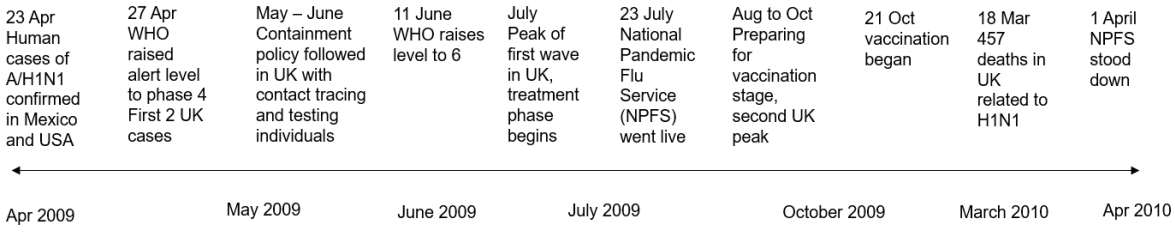
Case study #3 – The 2009 influenza pandemic

Introduction

The 2009 influenza pandemic was a global outbreak of a new strain of influenza A virus (subtype H1N1). It was first identified in April 2009 in Mexico and the WHO named the virus A(H1N1)pdm09, but was colloquially called swine flu. The outbreak quickly spread globally and was declared a pandemic on 11 June 2009 by WHO. The majority of patients experienced only mild symptoms however higher risk groups were more likely to experience more severe symptoms.

After the first UK cases were confirmed on 27 April 2009, the virus spread with a peak in July 2009, but declined sharply in the first week of August 2009 to then rise again in October 2009. The number of cases then declined and by April 2010, the National Pandemic Flu Service (NPFS) which was set up to supplement the response provided by primary care and comprised of an online and telephony self-assessment service, was stood down indicating the end to the UK response. Overall 457 deaths were attributed to H1N1.

Timeline (April 2009 – April 2010)



Key publications

1. The 2009 Influenza Pandemic: An Independent Review To The UK Response To The 2009 Influenza Pandemic - (Hine, 2010).
2. Report of the WHO Pandemic Influenza A(H1N1) Vaccine Deployment Initiative (World Health Organization, 2012).

Outcome/improvements

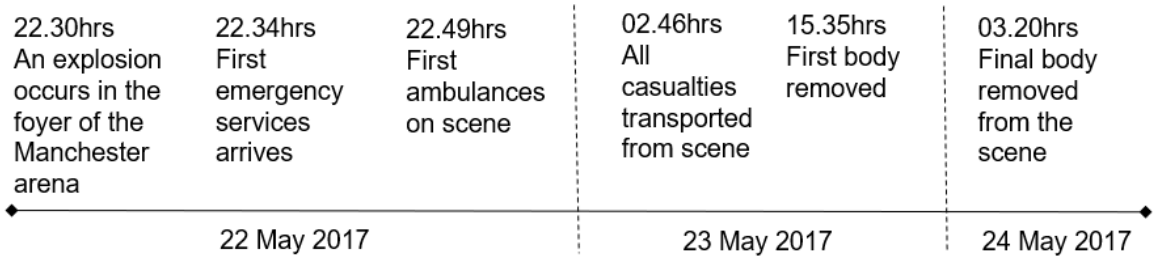
The definitive UK outcome from the pandemic was captured in the Hine report (2010). This publication cited 28 recommendations covering eight key areas including communications, scientific advice and the central government advice. Summing up the findings the author reported that "*the planning for the pandemic was well developed, the personnel involved were fully prepared, the scientific advice provided was expert, communication was excellent, the NHS and public health services right across the UK and their suppliers responded splendidly, and the public response was calm and collaborative*." (Hine, 2010, p1). The report acknowledged that the danger of another, possibly more severe, pandemic had not receded, and that the UK should use the learning from this event to better prepare for the future.

Case study #4 – The 2017 Manchester Arena bombing

Introduction

On 22 May 2017, a suicide bombing attack took place in the foyer of the Manchester Arena. Twenty-three people died and 139 were wounded. The incident was the deadliest terrorist attack since the 7 July 2005 London bombings and the first suicide bombing in the United Kingdom. After the Paris attacks of November 2015, NHS England requested assurance from NHS Trusts on their preparedness and readiness for a major incident. Following the approach, the Emergency Response Department of Public Health England facilitated a simulated mass casualty exercise using ETS in Manchester. Exercise Socrates was delivered three weeks before the bombing and was cited in the Kerslake report.

Timeline (22 – 24 May 2017)



Key publications

1. The Kerslake Report: An independent review into the preparedness for, and emergency response to, the Manchester Arena attack on 22nd May 2017 (Kerslake et al., 2017).
2. Manchester Arena bombing: lessons learnt from a mass casualty incident. (Craigie et al., 2018).

Outcome/improvements

A key publication about this incident was the Kerslake report which provided an independent review into the preparedness for, and emergency response to, the Manchester Arena attack. The report noted that multi-agency planning and exercising provided a high level of confidence in the partner agencies to be able to act. However, it stated that Greater Manchester Fire and Rescue Service was brought to a 'point of paralysis' by the incident. It also expressed criticism of some news media, citing intrusive and overbearing behaviour by some media.

Craigie et al reviewed the incident from the perspective of learning lessons from a mass casualty incident for healthcare. The paper reported five key messages that the event highlighted. These included: mandatory definitive surgical trauma skills for civilian surgeons; that patient identification following a mass casualty incident is difficult and that mass casualty incidents result in a significant knock-on effect for all acute medical services in the region.

A2. Nine key publications non-technical skill lists

Publication, Author (s), year	Name	NTS list	Sub-skill
1. Crew resource management: improving team work in high reliability industries Flin et al. 2002	CRM	Situation awareness	Plant status awareness Environmental awareness Anticipation Concentration/avoiding distraction Shared mental models
		Decision-making	Problem definition/diagnosis Risk and time assessment Recognition primed decision-making/procedures/analytical Option generation/choice Outcome review
		Communication	Assertiveness/speaking up Asking questions Listening Giving appropriate feedback Attending to non-verbal signals
		Team working	Maintaining team focus Considering others Supporting others Team decision-making Conflict solving
		Personal resources	Identifying and managing stress

		Supervision/leadership	Reducing/coping with fatigue Physical and mental fitness Use of authority/assertiveness Maintaining standards Planning and coordination Workload management
2. Development of the NOTECHS system for assessing pilots' CRM skills Flin, Martin, Goeters, Hormann 2003	NOTECHS Output from the Joint Aviation Regulation Translation and Elaboration of Legislation (JAR TEL) research which started in 1997 Used: • existing systems to ID common categories and elements of behaviour • literature review • discussions with SME	Cooperation (social skill) Leadership and managerial skills (social skill) Situation awareness (cognitive skill) Decision-making (cognitive skill)	Team building and maintaining Considering others Supporting others Conflict solving Use of authority and assertiveness Providing and maintaining standards Planning and coordination Workload management Awareness of aircraft systems Awareness of external environment Awareness of time Problem definition and diagnosis Option generation Risk assessment and option selection Outcome review
3. Anaesthetists' Non-Technical Skills (ANTS): evaluation of a behavioural marker system	ANTS Based framework on NOTECHS Used: • Cognitive task analysis interviews	Task management Team working	Planning and preparing Prioritizing Providing and maintaining standards Identifying and utilising resources Coordinating activities with team members

Fletcher, Flin, Glavin, Maran, Patey 2003	(29 interviews) • Grounded theory approach to identify skills	Situation awareness	Exchanging information Using authority and assertiveness Supporting others Gathering information Recognising and understanding anticipating
		Decision-making	Identifying options Balancing risks and selecting options Re-evaluating
4. Identifying and training NTS of nuclear response teams Crichton & Flin 2004	Nuclear emergency response teams Based on Flin & O'Connor 2002 No sub categories	Decision-making Communication Situation awareness Teamwork Leadership Stress management	*Considered but not used further due to lack of sub-skill definitions*
5. Incident command skills in the management of an oil industry drilling incident Crichton, Lauche, Flin 2005	Oil industry incident management team	Situation assessment	Information gathering Shared awareness Projection/prediction Expectations
		Decision-making	Problem definition Diagnosis Option generation Risk and time assessment Response selection Outcome review
		Teamwork	Team and workload management Coordination of activities
		Leadership	Command

			Planning and re-planning Provide direction Delegation Communication Communication with others
6. Development of a rating system for surgeons' non-technical skills Yule, Flin, Paterson-Brown, Maran, Rowley 2006	NOTSS Ver 1.2 shorter Used: • Cognitive task analysis interviews (27 interviews) • Literature search • Task analysis	Situation awareness	Gathering information Understanding information Projecting and anticipating future state
		Decision-making	Considering options Selecting and communication option Implementing and reviewing decisions
		Task management	Planning and preparation Flexibility/responding to change
		Leadership	Setting and maintaining standards Supporting others Coping with pressure
		Communication and teamwork	Exchanging information Establishing a shared understanding Coordinating team activities
7. A pilot study using high fidelity simulation to formally evaluate performance in the resuscitation of critically ill patients	Ottawa Global rating scale Extracted from book by Gaba (1994) 7-point Likert scale	Leadership	Stay calm and in control during crisis Prompt firm decision-making Maintains global perspective
		Situational awareness	Avoids fixation error Reassesses and re-evaluates situation constantly
		Communication	Communicates clearly and concisely Uses directed verbal/non-verbal communication

Kim, Neilipovitz, Cardinal, Chiu & Clinch 2006			Listen to team input
		Problem solving	Organised and efficient problem-solving approach Quick in implementation Considers alternatives during crisis
		Resource utilisation	Calls for help appropriately Utilises resources at hand appropriately Prioritizes tasks appropriately
8. Rail Safety and Standards Board (RSSB) Non-technical skills Kate Bonsall-Clarke 2008	RSSB non-technical skills	Situation awareness	Attention to detail Overall awareness Maintain concentration Retain information (during shift) Anticipation of risk
		Conscientiousness	Systematic and through approach Checking Positive attitude towards rules and procedures
		Communication	Listening (people not stimuli) Clarity Assertiveness Sharing information
		Decision-making and action	Effective decisions Timely decisions Diagnosing and solving problems
		Cooperation and working with others	Considering others' needs Supporting others

			Treating others with respect Dealing with conflict/aggressive behaviour
		Workload management	Multi-tasking and selective attention Prioritising Calm under pressure
		Self-management	Motivation Confidence and initiative Maintain and develop skills and knowledge Prepared and organised
9. NTS for enhancing patient safety Kodate, Ross, Anderson, Flin 2012	NTS Used Engel 2008	Situation awareness	Gathering information Recognising and understanding Anticipating future states
		Decision-making	Defining the problem Identifying the options balancing risks and selecting options reassessing/reviewing outcomes
		Communications skills	Giving information clearly and concisely Including context and intent Receiving information Identifying and tackling barriers to communication
		Team working	Supporting others Solving conflicts Exchanging information Coordinating activities
		Leadership	Using authority and assertiveness Maintaining standards

			Planning and prioritising Managing workload and resources
		Stress management	Identifying symptoms of stress Recognising effects of stress Implementing coping strategies
		Fatigue management	Identifying symptoms of fatigue Recognising effects of fatigue Implementing coping strategies
NGT (pilot) Middlemiss April 2015 (included for completeness)	HEPE skills	Leadership	Motivating people to perform the task in hand, to follow the plan, inspire the team to follow your direction, setting a good example and inspiring confidence
		Communication	Communicate effectively with external and internal, to ensure the right information is passed on and delivered in confidence, with a group of people, with an individual and upwards and downwards - both verbal and written. To communicate effectively and efficiently - clarity (being able to identify a message and communicate it)
		Team work	Working with the team to achieve the objective and best outcome
		Problem solving	Identifying what is important and approaching it - being able to identify a problem and solving it promptly
		Flexibility / adaptability	Take on different tasks, to be able to extend or change what you are doing - to recognise

	something that needs doing that is not being done - Adapting to circumstances as they happen
Anticipation	Peoples ability to anticipate what is coming - the ability to forward think and put measures in place
Decision-making	Ability to make a decision - clear and decisive Recognising the implications of your actions on yourself and others; accountability of decisions taken
Calm and logical	To be calm and logical
Strategic thinking	The ability to see wider picture
Cooperative working	Different teams, working in a larger team together
Prioritising	Both for individuals and teams - the ability to look at the workload and prioritise into a categorised list - breaking it down to now, wait and wait longer

A3. The non-technical skills extracted from key publications

Skill number	Skill Name	Sub-skill
1	Anticipation	People's ability to anticipate what is coming - the ability to forward think and put measures in place
2	Calm and logical	To be calm and logical
3	Communication	Assertiveness/speaking up Asking questions Listening Giving appropriate feedback Attending to non-verbal signals
4	Communication	Communicates clearly and concisely Uses directed verbal/non-verbal communication Listen to team input
5	Communication	Listening (people not stimuli) Clarity Assertiveness Sharing information
6	Communication	Communicate effectively with external and internal partners, to ensure the right information is passed on and delivered in confidence, with a group of people; with an individual; upwards and downwards - both verbally and in written format. To communicate effectively and efficiently; clarity (being able to identify a message and communicate it)
7	Communication and teamwork	Exchanging information Establishing a shared understanding Coordinating team activities

8	Communications skills	Giving information clearly and concisely Including context and intent Receiving information Identifying and tackling barriers to communication
9	Conscientiousness	Systematic and through approach Checking Positive attitude towards rules and procedures
10	Cooperation	Team building and maintaining Considering others Supporting others Conflict solving
11	Cooperation and working with others	Considering others' needs Supporting others Treating others with respect Dealing with conflict/aggressive behaviour
12	Cooperative working	Different teams, working in a larger team together
13	Decision-making	Problem definition/diagnosis Risk and time assessment Recognition primed decision-making/procedures/analytical Option generation/choice Outcome review
14	Decision-making	Identifying options Balancing risks and selecting options Re-evaluating

15	Decision-making	Problem definition Diagnosis Option generation Risk and time assessment Response selection Outcome review
16	Decision-making	Considering options Selecting and communication option Implementing and reviewing decisions
17	Decision-making	Defining the problem Identifying the options balancing risks and selecting options reassessing/reviewing outcomes
18	Decision-making	The ability to make a decision - clear and decisive Recognising the implications of your actions on yourself and others; accountability of decisions taken
19	Decision-making	Problem definition and diagnosis Option generation Risk assessment and option selection Outcome review
20	Decision-making and action	Effective decisions Timely decisions Diagnosing and solving problems
21	Fatigue management	Identifying symptoms of fatigue Recognising effects of fatigue Implementing coping strategies

22	Flexibility / adaptability	Take on different tasks, to be able to extend or change what you are doing - to recognise something that needs doing that is not being done - Adapting to circumstances as they happen
23	Leadership	Command Planning and re-planning Provide direction Delegation Communication Communication with others
24	Leadership	Setting and maintaining standards Supporting others Coping with pressure
25	Leadership	Stay calm and in control during crisis Prompt firm decision-making Maintains global perspective
26	Leadership	Using authority and assertiveness Maintaining standards Planning and prioritising Managing workload and resources
27	Leadership	Motivating people to perform the task in hand, to follow the plan, inspire the team to follow your direction, setting a good example and inspiring confidence
28	Leadership and managerial skills (social skill)	Use of authority and assertiveness Providing and maintaining standards Planning and coordination Workload management

29	Personal resources	Identifying and managing stress Reducing/coping with fatigue Physical and mental fitness
30	Prioritising	both for individuals and teams - the ability to look at the workload and prioritise into a categorised list - breaking it down now/wait and wait longer
31	Problem solving	Organised and efficient problem solving approach Quick in implementation Considers alternatives during crisis
32	Problem solving	Identifying what is important and approaching it - being able to identify a problem and solving it promptly
33	Resource utilisation	Calls for help appropriately Utilises resources at hand appropriately Prioritises tasks appropriately
34	Self-management	Motivation Confidence and initiative Maintain and develop skills and knowledge Prepared and organised
35	Situation assessment	Information gathering Shared awareness Projection/prediction Expectations
36	Situation awareness	Plant status awareness Environmental awareness Anticipation Concentration/avoiding distraction Shared mental models

37	Situation awareness	Gathering information Recognising and understanding Anticipating
38	Situation awareness	Gathering information Understanding information Projecting and anticipating future state
39	Situation awareness	Attention to detail Overall awareness Maintain concentration Retain information (during shift) Anticipation of risk
40	Situation awareness	Gathering information Recognising and understanding Anticipating future states
41	Situation awareness	Awareness of aircraft systems Awareness of external environment Awareness of time
42	Situational awareness	Avoids fixation error Reassesses and re-evaluates situation constantly
43	Strategic thinking	Ability to see wider picture
44	Stress management	Identifying symptoms of stress Recognising effects of stress Implementing coping strategies

45	Supervision/leadership	Use of authority/assertiveness Maintaining standards Planning and coordination Workload management
46	Task management	Planning and preparing Prioritising Providing and maintaining standards Identifying and utilising resources
47	Task management	Planning and preparation Flexibility/responding to change
48	Team work	Working with the team to achieve the objective and best outcome
49	Team working	Maintaining team focus Considering others Supporting others Team decision-making Conflict solving
50	Team working	Coordinating activities with team members Exchanging information Using authority and assertiveness Supporting others
51	Team working	Supporting others Solving conflicts Exchanging information Coordinating activities
52	Teamwork	Team and workload management Coordination of activities

53	Workload management	Multi-tasking and selective attention Prioritising Calm under pressure

APPENDIX B

B1. Ten step Nominal Group Technique plan

1. Introductory statement
   - Welcome and individual introductions – discussion limited in early stages.
   - Role of the group – to contribute perceptions/experiences and expertise to define and describe non-technical skills.
   - Tasked to recall and describe their experience in a challenging situation; a critical incident or during an ETS delivery and list the skills[17] they believed were important in the resolution/management of the situation or incident and represented good practice.
   - Provide example of a NTS not an attribute – see footnote.
   - Need cooperation of all.
   - Focus on the problem (defining NTS[18]) not on solutions (why NTS not evident or achieved).
   - Any questions?

2. Initial generation of NTS skill list
   Participants will now spend 10 minutes reviewing the available NTS (on 53 small cards) and select the ones they believe are relevant to emergency response in a healthcare setting in silence and without discussion with other participants. New ones can be created if required (use blank cards) if they are missing from the list. The skills can also be adapted to be re-worded as required.

3. A round-robin of NTS (combined with stage 4)
   Participants asked to articulate one skill at a time in rotation around the group until all NTS selected are aired and displayed on the board – if new, possibly defined in one or two phrases/sub-skills. Consider discussion and rewording of secondary/supporting skills.

4. A clarification of the NTS
   The group will consider each NTS to clarify and agree a meaning the entire panel understands.

5. A generation of top 10 NTS lists
   Participants individually select the 10 skills they feel are the most important and record them on the worksheet (no discussion) are reversed scored.

6. NTS ranked on spreadsheet to present back to participants.
   The worksheets are collected and entered on a spreadsheet along with the ranking scores (rank 1 = 10). A total score is calculated for each entry and the top 10 scores are put on a flip chart to present back to the group.

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17 Skill is something you attain through training and repetition, while an attribute is a personal trait. Attribute such as cheerful or sense of humour. Skill such as driving safely

18 Peller et al. (2013) describe NTS as '*a combination of cognitive and social skills, which complement knowledge and technical skills and contribute to safe performance*' (p395)

7. Time out and icebreaker/comfort break.

8. Group top 10 and discussion of issues.
   Does the group agree with the rankings?
   Are there some obvious omissions? If so why?

9. Re-ranking of the issues.
   Participants re–rank the 10 skills identified by the group on the worksheet. No discussion with the group and assign a weighting between 100 – 1.
   Rank 1 = 100 and rank 10 = 1. The ranks in between can have any weighting between 99 – 2. These scores are entered on a spreadsheet and summed to give a mean individual weighting for each skill.

10. Conclude and close.

B2. Research ethics approval information

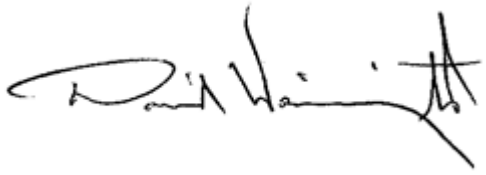
Department for Health Research Ethics Approval Committee for Health

Title of study	An evaluation of the non-technical skills development through emergency preparedness, resilience and response (EPRR) exercises for health sector personnel
Chief investigator (for research student projects, put research supervisors name here) (for undergraduate projects, put project supervisors name here)	Name: Vanessa Middlemiss e-mail: vmiddlemiss@bath.ac.uk Telephone: 07766 367194 01980 612958
Other investigators (for research student projects, put students name here) (for undergraduate projects, put student(s) name here)	Name: e-mail: Telephone:
Source of funding for the study	The research will be funded by Public Health England
Proposed dates of study	Q4 2015 to 2018
Research question	How effective are emergency responses exercises in developing non-technical skills of NHS personnel?
Background (less than 100 words)	Health emergency preparedness exercises (HERE) are the culmination of a programme of preparedness that the NHS must undertake. In spite of nearly universal acceptance of the claim that emergency preparedness exercises produce a variety of benefits, there are few empirical studies to support this, particularly focused on individual skill development. This study will look to describe and define the non-technical skills (NTS) a health emergency preparedness exercise develops. These skills once defined, measured, documented and analysed will enable future exercises to be more effectively designed to develop non-technical skills to enhance the exercise and gain greater value for money.
Methods (less than 300 words)	Overview: This project will take a mixed methodology approach and use two principal methods to collect data; a nominal group technique, followed by cross sectional survey. The research will use the Emergo Train System (ETS) as a platform. ETS is an interactive simulation system that can be used to simulate emergencies in a

	health setting. The system is a controlled, repeatable and safe environment. There are 24 events delivered every year from the Emergency Response Department of Public Health England. Each course has approximately 50 delegates. This equates to 1200 potential participants for stage two. Stage one: This stage will use a nominal group technique. The target group will be a selection of emergency response experts and members of the UK faculty for ETS. These experts have insights into ETS and emergency response skills, which will complement each other. They will define and describe the NTS appropriate for emergency response. The output will be a ranked NTS taxonomy to be used in stage two. Stage two: This stage will utilise a cross sectional survey. The survey will be designed to apply the taxonomy from stage one. Participants will be purposively sampled from the possible 1200 in a one-year PHE delivery period. All participants will undertake a pre and post ETS survey. The data will be quantitative and be analysed using SPSS.
Sample size (or equivalent qualitative approach)	Stage one: up to 18 Stage two: up to 1200
Proposed Analysis	Stage one: Analysis will be minimal as the NGT process will produce a useable output (ranked taxonomy). Stage two: SPSS will be used and will utilise a variety of variables and will be pre-coded and anonymous
Potential risks to volunteers	There is no physical risk to participants. There is a possibility that some participants in stage two may find the survey challenging. Responses will be coded for anonymity so personal/reputational risk is negligible
Potential for pain/discomfort	Nil
Benefits to participants	Participants will get the opportunity to describe their experience and this will influence the experience they have with ETS next time. They can directly improve the operating ETS system
How will participants be recruited?	Stage one: Approached by the researcher based on experience, suitability and availability for the NGT date Stage two: Participants nominations are received in ERD 6 weeks in advance of each event and each participant will be contacted to gain their informed consent to take part in the survey. They will be inducted and participate in the surveys via an online portal

Exclusion/inclusion criteria	This research will be focused on inclusion rather that exclusions. All participants must give informed consent. Stage one: Inclusion only of those with requisite experience and knowledge Stage two: Inclusion of all those giving informed consent and are willing to take part in both pre and post ETS surveys.
How will participants consent be taken?	Via a signed consent form. This form will give an overview of and significance of the research and why they should take part. The form will give all necessary information for participants to assess the research and make an informed decision to take part. This will be used for both stages.
How will confidentiality be ensured?	Responses will be coded and data will be controlled in accordance with the PHE security protocols

Signed by: Principal Investigator or Student Supervisor



Date: 14 Jan 2015

Signed by: Student

Date: 14 Jan 2015

Considered by REACH at meeting on: 11 Feb 2015

Decision of REACH:

Thank you for your response to the Committee's queries. I can confirm that the Chair of REACH, Dr Gordon Taylor, has reviewed the updated paperwork and your comments and is happy to approve this by Chair's action.

Please inform REACH about any substantial amendments made to the study if they have ethical implications.

B3. Information sheet: Stage one study

Thank you very much for considering taking part in this study. Before you decide to take part in stage one of the study, it is important that you understand why the study is being carried out and what it will involve. Please take the time to read the following information carefully, and contact me if there is anything that is unclear, or if you would like more information.

What is the purpose of the study?
This study will examine individual skill development from participating in health emergency preparedness exercises. This study will use participation in PHE delivered Emergo Train System (ETS)[19] to investigate the changes in individual's perception of the skills used during these exercises; specifically the study will consider changes in non-technical skills (NTS) before and after an ETS exercise.

The study will be conducted in two stages; stage one will be a discussion group, stage two will be a pre and post ETS exercise online survey.

How will stage one of the study take place?
You will be involved in a discussion group and you will apply your knowledge, experience of emergency response skills and/or insight into ETS. As part of this group, you will define and describe the skills appropriate for an emergency response. You will be asked to recall and describe your experience in a challenging situation and/or a critical incident and to list the skills you believed were important in resolution of the situation/incident. The list of skills will be used in stage two. You will not be part of stage two.

How will stage two of the study take place?
This stage will be conducted online and will involve completing two short surveys, one before participating in an ETS exercise and one immediately after the exercise.

What do I do if I am interested?
If you would like to take part in stage one, please read the rest of this information sheet and contact me using the details below to be invited to the take part in the study. If you would like further information or have any concerns, please contact me on the details below.

<u>Please note, you are under no obligation to take part and you are free to withdraw from the study at any time.</u>

Please contact: Vanessa Middlemiss, telephone: 01980 612958
Email: Vanessa.middlemiss@phe.gov.uk

Further Information
The study aim is to examine the effectiveness of contemporary health emergency preparedness exercises in enhancing the non-technical skills of health sector staff.

Participants in stage one of the study will be invited experts from a range of health backgrounds across the NHS and other complementary emergency response professions.

Participants in stage two of the study will be those NHS employees who are taking part in PHE organised ETS exercises and will be from a selection of NHS Trusts across England. Stage two will require participants being asked a series of questions about themselves, their experience and their perception of the skills both pre and post exercise.

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19 ETS is an interactive simulation platform that can be used to replicate emergencies in a healthcare setting (Hospital A & E). ETS provides a controlled, repeatable and safe environment.

It is anticipated that the study will be used to inform the future development of health emergency preparedness exercise to make them more effective at personal development of individual's skills.

You will not be identifiable from the data that you provide as part of the study. Information that you provide as part of responses to the study will be held, however it will not be possible to identify you from published results. Once the information has been collected, the only person who will have access is the named research contact above.

If you decide to take part you will asked to give informed consent.

How will my information be stored / used in the future?
The data you provide during this study will be kept confidential and anonymous in accordance with the 1998 Data Protection Act. At no point will any data be associated with your name or identity. Once the data has been analysed, it may be used in publications in academic journals and reports, but you will not be identified at any point.

Who has reviewed this study?
All research in the NHS is looked at by an independent group called a Research Ethics Committee to protect your safety, rights, wellbeing and dignity. This study has been reviewed by the University of Bath Ethics committee.

Complaint
In case of any complaint, please contact my supervisor on:

Dr Andrew Weyman
University of Bath
Tel: 01225 385279
Email: a.weyman@bath.ac.uk

B4. Stage one consent form

INFORMED CONSENT FORM

Title of Project: An evaluation of the non-technical skills development through emergency preparedness, resilience and response (EPRR) exercises for health sector personnel

Name of Researcher: Vanessa Middlemiss

Please tick all boxes*

1. I confirm that I have read and understand the information sheet dated 11/12/2015 (version 0.5 – stage one) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time without giving any reason, without my legal rights being affected. ☐

3. I understand that any information collected during this study will be held confidentially, in accordance with the Data Protection Act 1998. ☐

4. I understand that the outcomes of this study may be published and that individuals participating in the study will not be identified in any of these publications. ☐

5. I agree to take part in the above study. ☐

Name of participant:_____

* by ticking the boxes you are giving consent to take part in the study

B5. Principal Nominal Group Technique outputs

Initial top ranked NTS

	Skill No.	Description of NTS	Score participant 1	Score participant 2	Score participant 3	Score participant 4	Score participant 5	total	rank
1	18	Decision-making	10	10	10	8	10	48	1
2	1	Anticipation	4	9	4	6	9	32	2
3	6	Communication		7	6	7		20	3
4	38	Situation awareness	6			5	8	19	4
5	27	Leadership			9	10		19	5
6	43	Strategical thinking		1	8	9		18	6
7	53	Workload management	2		3	4	7	16	7
8	8	Communication	9		2			11	8
9	54	roles and responsibility		4			4	8	9
10	9	Conscientiousness		8				8	9
11	23	Leadership	8					8	9
12	33	Resource utilisation	1			2	5	8	9
13	50	Team working			5	3		8	9
14	42	Situation awareness		2				2	
15	21	Fatigue management				1	2	3	
16	40	Situation awareness		3				3	
17	22	Flexibility and adaptability	3				1	4	
18	34	Self-management			1		3	4	
19	46	Task management	5					5	
20	48	Teamwork		5				5	
21	26	Leadership					6	6	
22	35	Situation assessment		6				6	
23	47	Task management			7			7	

24	49	Team working	7	7
25	2	Calm and logical		
26	44	Stress management		
27	3	Communication		
28	10	Cooperation		
29	11	Cooperation and working with others		
30	12	Cooperative working		
31	15	Decision-making		
32	16	Decision-making		
33	39	Situation awareness		
34	30	Prioritising		
35	32	Problem solving		

B6. Ranked skills (with weighting) from stage one

Skill No.	Participant NTS construct	1	2	3	4	5	total weighting	mean weighting	rank	Selection criteria	Rank for the survey
18	Decision-making	100	100	100	100	100	500	100	1	amenable to change	1
27	Leadership	90		85	75	95	345	86.25	2	amenable to change (linked to skill 23)	2
38	Situation awareness	75	80		90	90	335	83.75	3	amenable to change (linked to skill 43)	3
6	Communication	85		79	89	80	333	83.25	4	amenable to change (linked to skill 8)	4
1	Anticipation	80	90	77	70		317	79.25	5	not amenable to change in HEPE	
43	Strategic thinking	70	60	80	85	60	355	71	6	linked to skill 38	
53	Workload management	50		70	50	70	240	60	7	Duplicate of skill 27	
8	Communication skills		50	65		65	180	60	7	linked to skill 6	
54	Roles and responsibility	1	1	78	65	75	220	44	9	Knowledge rather than a skill	
33	Resource utilization	40	70	1	55	50	216	43.2	10	sub set of decision-	

50	Team working	60	40	60	1	1	162	32.4	11	making amenable to change	5
23	Leadership		30				30	30	12	linked to skill 27	
9	Conscientiousness		20				20	20	13	not amenable to change in HEPE	

APPENDIX C

C1. Detailed diagram of five phases of stage two

Phase one – 1st Pilot pre ETS survey PHE internal 13 surveys completed Date range for completion: 26 Feb to 6 Mar 15 Skills questions: 16 representative skills; 4 levels from V good to poor plus need to develop and NA	Phase one – 1st Pilot post ETS survey PHE internal 13 surveys completed Date range for completion: 26 Feb to 6 Mar 15 Skills questions: 16 representative skills; 4 levels from V good to poor plus need to develop and NA
Phase two - 2nd Pilot pre survey External – London ETS - 30 June 15 10 surveys completed Date range for completion: 4 June to 28 June 15 Skills questions: 11 skills from pilot NGT - 4 levels from V good to poor plus need to develop and NA	Phase two - 2nd Pilot post survey External – London ETS - 30 June 15 9 surveys completed Date range for completion: 1 to 14 July Skills questions: 11 skills from pilot NGT - 4 levels from V good to poor plus need to develop and NA
Phase three - Cognitive Pilot pre survey PHE internal 4 surveys completed Date range for completion: 5 April 16 Skills questions: 5 skills from principal NGT - 5 level Likert scale strongly agree to strongly disagree (mid-point neither agree nor disagree)	Phase three - Cognitive Pilot post survey PHE internal 4 surveys completed Date range for completion: 21 to 26 April 16 Skills questions: 5 skills from principal NGT - 5 level Likert scale strongly agree to strongly disagree (mid-point neither agree nor disagree)
Phase four - 3rd Pilot pre survey External – Bristol ETS on 27 September 16 9 surveys completed Date range for completion: 25 to 27 Sept 16 Skills questions: 5 level Likert scale strongly agree to strongly disagree (mid-point neither agree nor disagree)	Phase four - 3rd Pilot post survey External – Bristol ETS on 27 September 16 9 surveys completed Date range for completion: 28 Sept to 14 Oct 16 Skills questions: 5 level Likert scale strongly agree to strongly disagree (mid-point neither agree nor disagree)
Phase five - Main pre survey Plymouth, Leeds & Wessex TV ETS ETS delivered on: 2, 9 and 24 Nov 16 78 surveys completed Date range for completion: 24 Oct to 17 Jan 17 Skills questions: 5 level Likert scale strongly agree to strongly disagree (mid-point neither agree nor disagree)	Phase five - Main post survey Plymouth, Leeds & Wessex TV ETS ETS delivered on: 2, 9 and 24 Nov 16 80 surveys completed Date range for completion: 3 Nov 16 to 2 Jan 17 Skills questions: 5 level Likert scale strongly agree to strongly disagree (mid-point neither agree nor disagree)

C2. A table showing the NTS construct questions (composite NTS)

Q	NTS construct
	Communications NTS construct
1	C1.1 I find it difficult communicating to people in an effective, efficient and timely manner with all levels (internal, external, individuals and groups)
2	C2.1 I find that I have the skills to clearly communicate information to people
3	C4.1 I feel confident communicating with all levels (internal, external, individuals and groups)
4	C5.1 I find it difficult to get people to listen to what I have to say
	Decision-making NTS construct
5	DM1.1 I feel confident that I have the skills to make timely decisions
6	DM2.1 I find it difficult to log and document decisions I have made
7	DM3.1 I find it difficult to make clear decisive decisions
8	DM4.1 I recognise the implications of my actions on myself and others
	Leadership NTS construct
9	L1.1 I find I can inspire confidence and keep perspective in the leadership role
10	L3.1 I find it difficult to plan and prioritise
11	L4.1 I find it difficult manage workload and resources
12	L5.1 I have the skills to motivate people to perform and follow my direction
	Situation awareness NTS construct
13	SA1.1 I feel confident in my ability to gather and understand information to develop situation awareness
14	SA2.1 I lack the confidence in my ability to consider, reassess and reject options
15	SA3.1 I feel I am able to project and anticipate future states to maintain situation awareness
16	SA4.1 I find it difficult to maintain situation awareness
	Team working NTS construct
17	TW1.1 I prefer to work individually than be part of team
18	TW2.1 I find it difficult to use authority and assertiveness as part of a team
19	TW3.1 I feel confident working as part of a team
20	TW4.1 I feel I have the ability to coordinate activities and exchange information as part of a team
21	TW5.1 I find it difficult to maintain team focus

C3. Information sheet: Stage two study

Thank you very much for considering taking part in this study. Before you decide to take part, it is important that you understand why the study is being carried out and what it will involve. Please take the time to read the following information carefully, and contact me if there is anything that is unclear, or if you would like more information.

What is the purpose of the study?
This study will examine skill development from participating in health emergency preparedness exercises. This study will use your participation in the PHE delivered ETS exercise and will investigate the changes in your perception of the skills you would use in an emergency; specifically the study will consider possible changes in non-technical skills.

Where and when will the study take place?
The study will be conducted online and will involve you completing two short surveys, one before participating in an ETS exercise and one immediately after the exercise. If you decide to participate, a link will be sent to you approximately six weeks before your participation in the ETS event and a second link immediately after the exercise for you to access the online site to complete each survey. Each survey should take no more than 20 minutes to complete. For the data to be of use, it is important to have two completed surveys from each participant.

What do I do if I am interested?
If you would like to take part, please read the rest of this information sheet and a link will automatically be sent to you to access the online site to complete the pre ETS survey. Additionally, if you would like further information or have any concerns, please contact me on the details below.

<u>Please note, you are under no obligation to take part and you are free to withdraw from the study at any time.</u>

Who should I contact for more information?
I would be very happy to discuss the study further and answer any questions. If you have a concern about any aspect of this study, you should contact me directly.

Please contact:
Vanessa Middlemiss
Telephone: 01980 612958
Email: Vanessa.middlemiss@phe.gov.uk

Further Information
The study aim is to examine the effectiveness of contemporary health emergency preparedness exercises in enhancing the non-technical skills of health sector staff.

Participants in the study will be those NHS employees who are taking part in PHE organised ETS exercises and will be from a selection of NHS Trusts across England.

If you agree to take part in the study, the process will require you being asked a series of questions about yourself, your experience and your perception of your skills both pre and post ETS exercise.

It is anticipated that the study will be used to inform the future development of health emergency preparedness exercise to make them more effective at personal development of individual's skills.

You will not be identifiable from the data that you provide as part of the survey. I will only collect your name to ensure that there is no duplication during the sampling process. Once all the data has been collected, your name will be deleted from the database. Information that you provide as part of responses to the survey will be held, however it will not be possible to identify you from published

results. Once the information has been collected, the only person who will have access is the named research contact above.

If you decide to take part you will asked to give informed consent via an online form. As participation is anonymous, it will not be possible for us to withdraw your data once you have returned your surveys.

How will my information be stored / used in the future?
The data you provide during this study will be kept confidential and anonymous in accordance with the 1998 Data Protection Act. At no point will any data be associated with your name or identity. Once the study data has been analysed, it may be used in publications in academic journals and reports, but you will not be identified at any point.

Who has reviewed this study?
All research in the NHS is looked at by an independent group called a Research Ethics Committee to protect your safety, rights, wellbeing and dignity. This study has been reviewed by the University of Bath Ethics committee.

Complaint
In case of any complaint, please contact my supervisor on:

Dr Andrew Weyman
University of Bath
Tel: 01225 385279
Email: a.weyman@bath.ac.uk

C4. Online survey pre and post ETS

The pre ETS Survey

Section one – Informed consent

1. I confirm that I have read and understand the participant information for the study[20].
2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time without giving any reason, without my legal rights being affected.
3. I understand that any information collected during this study will be held confidentially, in accordance with the Data Protection Act 1998.
4. I understand that the outcomes of this study may be published and that individuals participating in the study will not be identified in any of these publications.
5. I agree to take part in the study

Section two - Introduction

6. What is your name? (*Only used to link pre and post survey)*
7. What is your organisation? (*Only used to link pre and post survey)*
8. Indicate your age range? *16 – 25, 26 – 35, 36 – 45, 46 – 55, 56 – 65, over 65*
9. Current gender assignment? - How do you describe yourself? *Male, Female, Transgender, Do not identify as female, male or transgender*
10. What is your current role? *Medical staff, nursing staff, ancillary staff, clerical/management staff, other health professional, other (please state)*

Section three – Previous experience

11. Do you currently have an emergency response role in your organisation? *Yes or No*
12. How long have you had an emergency response role at your organisation? Less than *1 year, 1 year, 2 years, 3 years, 4 years, 5 years, over 5 years*
13. Have you received any emergency response training at your organisation? *Yes, No, No – none is offered/available*
14. How long ago was your emergency response training? *Less than 1 year, 1 year, 2 years, 3 years, 4 years, 5 years, over 5 years*
15. Did any of the emergency response training target the development of non-technical skills? *Yes or No*
16. Have you ever responded to a large scale emergency[21] at your organisation? *Yes or No*

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20 Provided via email and also at the start of the survey

17. How many times have you responded to a large scale emergency? 1, 2, 3, 4, 5, over 5

Section four – ETS participation

18. Have you participated in an ETS exercise before? *Yes or No*

19. How many times have you participated in an ETS exercise? *1, 2, 3, 4, 5 more than 5*

20. How long ago was the last ETS exercise you attended? *Less than 1 year, 1 year, 2 years, 3 years, 4 years, 5 years, over 5 years*

21. Why are you participating in the forthcoming ETS exercise? *Compulsory activity, develop responder skills, personal development, improve ability in current role, other*

Section five - Non-technical skill assessment pre ETS

Before you participate in the ETS exercise, please make an assessment of your current level of non-technical skill. To what extent do you agree or disagree with the following statements.

22. I have good decision-making skills – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

23. I have good leadership skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

24. I have good situation awareness skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

25. I have good communications skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

26. I have good team working skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

Section six - Non-technical skill assessment pre ETS (elements of each NTS)

27. (DM1) I feel confident I have the skills to make timely decisions – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

28. (TW3) I feel confident working as part of a team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

29. (L1) I find I can inspire confidence and keep perspective in the leadership role – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

30. (SA1) I feel confident in my ability to gather and understand information to develop situation awareness – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

31. (C1) I find it difficult communicating to people in an effective, efficient and timely manner with all levels (internal, external, individuals and groups) – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

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[21] Guidance on a 'large-scale' emergency was provided to respondents

32. (DM3) I find it difficult to make clear decisive decisions – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

33. (DM4) I recognise the implications of my actions on myself and others – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

34. (L5) I have the skills to motivate people to perform and follow my direction – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

35. (SA2) I lack the confidence in my ability to consider, reassess and reject options – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

36. (C4) I feel confident communicating with all levels (internal, external, individuals and groups) – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

37. (L3) I find it difficult to plan and prioritise – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

38. (DM2) I find it difficult to log and document decisions I have made – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

39. (L4) I find it difficult manage workload and resources – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

40. (C2) I find that I have the skills to clearly communicate information to people – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

41. (TW4) I feel I have the ability to coordinate activities and exchange information as part of a team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

42. (C5) I find it difficult to get people to listen to what I have to say – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

43. (TW3) I prefer to work individually than be part of team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

44. (TW2) I find it difficult to use authority and assertiveness as part of a team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

45. (SA3) I feel I am able to project and anticipate future states to maintain situation awareness – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

46. (SA4) I find it difficult to maintain situation awareness – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

47. (TW5) I find it difficult to maintain team focus – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

Section seven - Non-technical skill ranking

48. From the non-technical skills listed, please rank the skills in the order of importance with 1 being the most important non-technical skills you feel you would need to respond effectively in a real

emergency at your organisation to 5 being the least important - *Decision-making, Leadership, Situation awareness, Communications, Team working*

Section eight – Response assessment

49. Before you participate in your ETS exercise and based on your current level of training, experience and assessed level of non-technical skills, would you feel able to respond to a real emergency at your organisation? *Yes or No*

50. I feel confident to be able to respond to an emergency in my organisation – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

<u>The post ETS Survey</u>

Section one – Informed consent

1. I confirm that I have read and understand the participant information for the study[22].

2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time without giving any reason, without my legal rights being affected.

3. I understand that any information collected during this study will be held confidentially, in accordance with the Data Protection Act 1998.

4. I understand that the outcomes of this study may be published and that individuals participating in the study will not be identified in any of these publications.

5. I agree to take part in the study

Section two - Introduction

6. What is your name? (*Only used to link pre and post survey)*

7. What is your organisation? (*Only used to link pre and post survey)*

8. Indicate your age range? *16 – 25, 26 – 35, 36 – 45, 46 – 55, 56 – 65, over 65*

9. Current Gender assignment? - How do you describe yourself? *Male, Female, Transgender, Do not identify as female, male or transgender*

10. What is your current role? *Medical staff, nursing staff, ancillary staff, clerical/management staff, other health professional, other (please state)*

Section three – Previous experience

11. Have you received any emergency response training at your organisation? *Yes, No, No – none is offered/available*

12. Did any of your previous emergency response training aid your participation in the ETS exercise? *Yes or No*

13. Which skills did you find you could utilise in the exercise?

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22 Provided via email and also at the start of the survey

Section four - Non-technical skill assessment post ETS

Now you have participated in the ETS exercise, please make an assessment of your current level of non-technical skill. To what extent do you agree or disagree with the following statements.

14. I have good decision-making skills – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

15. I have good leadership skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

16. I have good situation awareness skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

17. I have good communications skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

18. I have good team working skills - *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

Section five - Non-technical skill assessment post ETS (elements of each NTS)

19. (DM1) I feel confident I have the skills to make timely decisions – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

20. (TW3) I feel confident working as part of a team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

21. (L1) I find I can inspire confidence and keep perspective in the leadership role – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

22. (SA1) I feel confident in my ability to gather and understand information to develop situation awareness – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

23. (C1) I find it difficult communicating to people in an effective, efficient and timely manner with all levels (internal, external, individuals and groups) – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

24. (DM3) I find it difficult to make clear decisive decisions – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

25. (DM4) I recognise the implications of my actions on myself and others – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

26. (L5) I have the skills to motivate people to perform and follow my direction – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

27. (SA2) I lack the confidence in my ability to consider, reassess and reject options – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

28. (C4) I feel confident communicating with all levels (internal, external, individuals and groups) – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

29. (L3) I find it difficult to plan and prioritise – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

30. (DM2) I find it difficult to log and document decisions I have made – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

31. (L4) I find it difficult manage workload and resources – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

32. (C2) I find that I have the skills to clearly communicate information to people – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

33. (TW4) I feel I have the ability to coordinate activities and exchange information as part of a team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

34. (C5) I find it difficult to get people to listen to what I have to say – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

35. (TW3) I prefer to work individually than be part of team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

36. (TW2) I find it difficult to use authority and assertiveness as part of a team – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

37. (SA3) I feel I am able to project and anticipate future states to maintain situation awareness – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

38. (SA4) I find it difficult to maintain situation awareness – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

39. (TW5) I find it difficult to maintain team focus – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

Section six - Non-technical skill ranking

40. From the list of non-technical skills, which (if any) of the skills were changed as a result of participating in the ETS exercise - *Decision-making, Leadership, Situation awareness, Communications, Team working, No change*

41. From the non-technical skills listed, please rank the skills in the order of importance with 1 being the most important non-technical skills you feel you would need to respond effectively in a real emergency at your organisation to 5 being the least important - *Decision-making, Leadership, Situation awareness, Communications, Team working*

42. Were other non-technical skills, not in the list above, changed as a result of your participation in the ETS exercise? *Yes or No*

43. What other non-technical skills (not already listed) have changed as a result of your participation in the ETS exercise?

44. Could any changes in your perceived level of non-technical skills be due to the following reasons? *Changes were due to participation in the ETS exercise, changes were due to a raising of awareness of the skills I already had, my previous training/experience gave me the skills I*

have, I did not feel there was any change in my non-technical skills after taking part in the ETS exercise, other

Section seven – Response assessment

45. Now you have participated in an ETS exercise and based on your current level of training, experience and assessed level of non-technical skills, would you feel able to respond to a real emergency at your organisation? *Yes or No*

46. I feel confident to be able to respond to an emergency in my organisation – *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*

47. Has participating in the ETS exercise made you feel more able to respond to a real emergency at your organisation? *Yes or No*

C5. Stage two consent form

INFORMED CONSENT FORM

Title of Project: An evaluation of the non-technical skills development through emergency preparedness, resilience and response (EPRR) exercises for health sector personnel

Name of Researcher: Vanessa Middlemiss

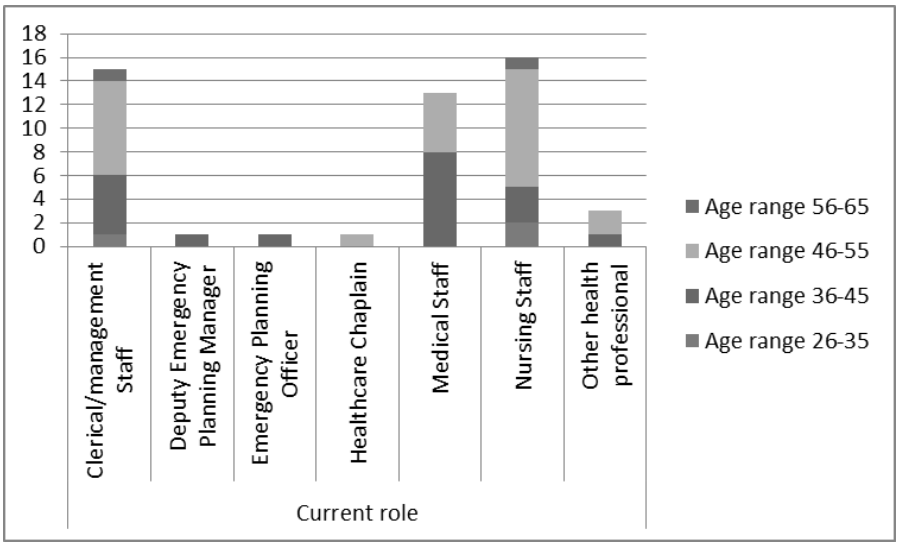
Please tick all boxes*

1. I confirm that I have read and understand the information sheet dated 6/01/2015 11/12/2015 (version 0.5 – stage two) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time without giving any reason, without my legal rights being affected. ☐
3. I understand that any information collected during this study will be held confidentially, in accordance with the Data Protection Act 1998. ☐
4. I understand that the outcomes of this study may be published and that individuals participating in the study will not be identified in any of these publications. ☐
5. I agree to take part in the above study. ☐

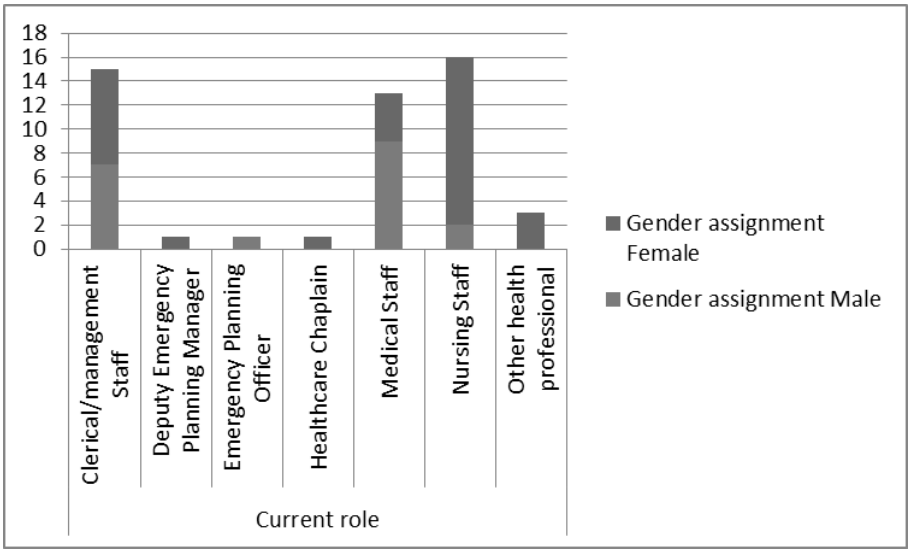
Name of participant:_____

* by ticking the boxes, you are giving consent to take part in the study

C6. A stacked bar chart showing age distribution of roles



C7. A stacked bar chart showing gender distribution of roles



C8. Compilation of survey results

Pre ETS summary results

Question number	Survey question
1 to 5	Informed consent: All respondents gave consent
6	Name: Identification number allocated to each respondent
7	Organisation: 27 NHS organisations took part in the survey from three areas - South West (Peninsula), Leeds and Thames Valley (Wessex)
8	Age range: 26-35 = 6%; 36-45 = 38%; 46-55 = 52%; 56-65 = 4%
9	Current gender assignment: Females = 62%; Males = 38%
10	Current role: Clerical/management Staff = 30%; Deputy Emergency Planning Manager = 2%; Emergency Planning Officer = 2%; Healthcare Chaplain = 2%; Medical Staff = 26%; Nursing Staff = 32%; Other = 6%
11	Currently emergency response role: Yes = 68%; No = 32%
12	How long have you had an emergency response role: Less than 1 year = 6%; 1 year = 6%; 2 years = 6%; 3 years 14%; 4 years = 6%; 5 years = 4%; Over 5 years = 26%; no role = 32%
13	Have you received any emergency response training: Yes = 82%; No = 18%
14	How long ago was your emergency response training: Less than 1 year = 38%; 1 year = 12%; 2 years = 8%; 3 years 8%; 4 years = 2%; Over 5 years = 14%; No training = 18%
15	Did any of the emergency response training target the development of NTS: Yes = 32%; No = 50%; No training = 18%
16	Have you ever responded to a large-scale emergency: Yes = 28%; No = 72%
17	How many times have you responded to a large-scale emergency: Not respond to emergency = 72%; 1 = 18%; 2 = 4%; 3 = 2%; 4 = 2%; 5 = 2%
18	Have you participated in an ETS exercise before: Yes = 36%; No = 64%
19	How many times have you participated in an ETS exercise: Not participated in ETS before = 64%; 1 = 22%; 2 = 6%; 3 = 6%; more than 5 = 2%
20	How long ago was the last ETS exercise you attended: Less than 1 year = 2%; 1 year = 2%; 2 years = 8%; 3 years 12%; 4 years = 4%; Over 5 years = 8%; Not participated before = 64%
21	Why are you participating in the forthcoming ETS exercise: To understand local hospitals ability to respond = 2%; As an exercise planner = 4%; Personal development = 20%; Asked to attend = 4%; Compulsory activity = 16%; Develop my responder skills = 20%; Improve my ability in my current role = 34%
22 to 47	The pre ETS descriptive results are shown in appendix C16
48	Rank the skills in the order of importance: 1. Communication; 2. Situation awareness; 3. Leadership; 4. Decision-making; 5. Team working
49	Feel able to respond to a real emergency: Yes = 88%; No = 10%; No answer 2%
50	Feel confident to be able to respond to an emergency: Strongly agree = 14%; agree = 56%; neither agree nor disagree = 20%; disagree = 8%; no answer = 2%

Post ETS summary results

Question number	Survey question
1 to 5	Informed consent: All respondents gave consent
6	Name: Identification number allocated to each respondent
7	Organisation: 27 NHS organisations took part in the survey from three areas - South West (Peninsula), Leeds and Thames Valley (Wessex)
8	Age range: 26-35 = 6%; 36-45 = 38%; 46-55 = 52%; 56-65 = 4%
9	Current gender assignment: Females = 62%; Males = 38%
10	Current role: Clerical/management Staff = 30%; Deputy Emergency Planning Manager = 2%; Emergency Planning Officer = 2%; Healthcare Chaplain = 2%; Medical Staff = 26%; Nursing Staff = 32%; Other = 6%
11	Have you received any emergency response training: Yes = 72%; No = 26%; No – none offered/available = 2%
12	Did any of your previous emergency response training aid your participation in the ETS exercise: Yes = 60%; No = 6%; no answer = 34%
13	Which skills did you find you could utilise in the exercise are shown in appendix C17
14 to 39	The post ETS descriptive results are shown in appendix C16
40	NTS changed as a result of participating in the ETS exercise: Communication 10%; Decision-making = 6%; Leadership = 4%; Situation awareness = 38%; Team working = 8%; No change = 34%
41	Rank the skills in the order of importance: 1. Communication; 2. Situation awareness; 3. Decision-making; 4. Leadership; 5. Team working
42	Were other NTS changed: Yes = 14%; No = 86%
43	What other NTS changed: Confidence and assertiveness = 2%; roles and responsibilities = 2%; awareness = 2%; work under pressure = 2%; other = 6%; no other NTS noted = 86%
44	Reasons for changes in your perceived level of NTS: Raising awareness = 22%; participation in ETS = 26%; deskilled = 2%; consolidated and gave confidence = 2%; no change in NTS = 34%; previous experience gave NTS = 14%
45	Feel able to respond to a real emergency: Yes = 100%; No = 0%
46	Feel confident to be able to respond to an emergency: Strongly agree = 28%; agree = 68%; neither agree nor disagree = 4%
47	Has participating in the ETS exercise made you feel more able to respond to a real emergency: Yes = 86%; No = 14%

C9. A table showing time in current emergency response role

Time in emergency response role	Currently have emergency response role			
	No	Yes	Total	%
Less than 1 year	0	3	3	6%
1 year	0	3	3	6%
2 years	0	3	3	6%
3 years	0	7	7	14%
4 years	0	3	3	6%
5 years	0	2	2	4%
Over 5 years	0	13	13	26%
Total	16	34	50	68%

C10. A table showing emergency response training received

	Emergency response training received at organisation			
		No	Yes	Total/(%)
Time since received emergency response training	Less than 1 year	0	19	19 (38%)
	1 year	0	6	6 (12%)
	2 years	0	4	4 (8%)
	3 years	0	4	4 (8%)
	4 years	0	1	1 (2%)
	Over 5 years	0	7	7 (14%)
	Total	9 (18%)	41 (82%)	50
Did the emergency response training target at NTS	No	0	25	25 (50%)
	Yes	0	16	16 (32%)
	Total	9	41	50

C11. A table showing training against aided ETS participation

	Received emergency response training at organisation			
	No	No or none available/offered	Yes	Total/(%)
Training aided participation in ETS	13	1	3	17 (34%)
No	0	0	3	3 (6%)
Yes	0	0	30	30 (60%)
Total	13	1	36	50

C12. A table showing experience of responding to an emergency

Times responded to a large-scale emergency	Ever responded to large scale emergency		
	No	Yes	Total/(%)
	36	0	36 (72%)
1	0	9	9 (18%)
2	0	2	2 (4%)
3	0	1	1 (2%)
4	0	1	1 (2%)
5	0	1	1 (2%)
Total	36 (72%)	14 (28%)	50

C13. A table showing the number of ETS participations

	Times participated in ETS					
Interval of time since last ETS participation	0	1	2	3	more than 5	Total/(%)
Not participated	32	0	0	0	0	32 (64%)
Less than 1 year	0	0	0	0	1	1 (2%)
1 year	0	1	0	0	0	1 (2%)
2 years	0	1	1	2	0	4 (8%)
3 years	0	6	0	0	0	6 (12%)
4 years	0	2	0	0	0	2 (4%)
Over 5 years	0	1	2	1	0	4 (8%)
Total	32 (64%)	11 (22%)	3 (6%)	3 (6%)	1 (2%)	50

C14. A table showing reasons for participating in ETS

Reason for participating in ETS	Frequency	%
To improve my ability in my current role	17	34%
To develop my responder skills	10	20%
As part of my personal development	9	18%
It is a compulsory activity	8	16%
As an emergency general surgeon to understand local hospitals ability to respond	1	2%
As an exercise planner	1	2%
I was asked to attend as a senior lead for ICU	1	2%
I was nominated by my Line Manager	1	2%
Supporting the exercise delivery as a Facilitator	1	2%
To model the response of the organisation as well as my personal skills	1	2%
Total	50	100%

C15. A table showing participant ability and confidence to respond

Ability to respond to a real emergency				Confidence to respond a real emergency			
		Frequency	%			Frequency	%
Pre	No	5	10%	Pre	Disagree	4	8%
Pre	Yes	44	88%	Pre	Neither agree nor disagree	10	20%
	Total	50	100%	Pre	Agree	28	56%
Post	Yes	50	100%	Pre	Strongly Agree	7	14%
Post	No	0	0%		Total	50	100%
	Total	50	100%	Post	Neither agree nor disagree	2	4%
				Post	Agree	34	68%
				Post	Strongly Agree	14	28%
					Total	50	100%

C16. A table showing total score for each primary NTS

	N	Sum	Mean	Std. Deviation	Skewness		Kurtosis	
				Statistic		Std. Error		Std. Error
Pre ETS								
I have good Decision-making skills	50	204	4.08	0.566	0.025	0.337	0.26	0.662
I have good Leadership skills	50	199	3.98	0.4734	-1.271	0.337	7.128	0.662
I have good Situation awareness skills	50	199	3.98	0.515	-0.034	0.337	1.065	0.662
I have good Communications skills	50	205	4.1	0.463	0.386	0.337	1.652	0.662
I have good Team working skills	50	215	4.3	0.505	0.396	0.337	-0.724	0.662
Post ETS								
I have good Decision-making skills	50	209	4.18	0.438	0.925	0.337	0.899	0.662
I have good Leadership skills	50	201	4.02	0.473	-1.134	0.337	7.569	0.662
I have good Situation awareness skills	50	209	4.18	0.482	0.487	0.337	0.609	0.662
I have good Communications skills	50	213	4.26	0.527	0.217	0.337	-0.3	0.662
I have good Team working skills	50	215	4.3	0.505	0.396	0.337	-0.724	0.662

C17. A table showing NTS used by participants in ETS

Primary skills included in survey
Communication x 2
Communication, leadership, teamwork, prioritising, managing staff, managing beds
Communication links; organisational awareness, health system knowledge;
Communication, leadership, understanding terminology,
Communication, leadership, decision-making
Decision-making
Leadership and planning
Leadership and logistics
Leadership, command awareness, briefing and debriefing skills
Leadership, knowledge
Leadership, previous clinical experience of managing an ED
Leadership, team working, recognising your own limits as an individual
Leadership, organisational skills
Team leadership and delegation
Team work
Additional elements mentioned by ETS participants
Command and Control x 2
ICC Management
Knowledge of certain parts of the hospital as some of it related to major incident
knowledge of policy and skills of recording decisions
Knowledge of pre-hospital triage categories
Knowledge of SCG and TCG responses
Loggist knowledge for clarity in communications
Managing emotional response of others; task allocation
The need to consider the broader implications of an incident and recovery from an early stage
Theory of triage, importance of closed loop communication,
Triage sieve and understanding the principles of a major incident
Underpinning process

C18. A table showing primary NTS changed by ETS participation

	Frequency	%
Situation awareness	19	38
No change	17	34
Communications	5	10
Team working	4	8
Decision-making	3	6
Leadership	2	4
Total	50	100

C19. A table showing reasons cited for primary NTS changes

	Frequency	%
I did not feel there was any change in my non-technical skills after taking part in the ETS exercise	19	38
Changes were due to participation in the ETS exercise	13	26
Changes were due to a raising of awareness of the skills I already had	11	22
My previous training/experience gave me the skills I have	7	14
Total	50	100

C20. A table showing primary NTS ranking by NGT and survey

Ranking	NGT experts	Pre ETS	Post ETS
1	Decision-making	Communications	Communications,
2	Leadership	Situation awareness	Situation awareness
3	Situation awareness	Leadership	Decision-making
4	Communications	Decision-making	Leadership
5	Team working	Team working	Team working

C21. A table showing paired sample t-tests for the five primary NTS

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I have good Decision-making skills pre	4.08	50	.566	.080
	I have good Decision-making skills post	4.18	50	.438	.062
Pair 2	I have good Leadership skills pre	3.98	50	.473	.067
	I have good Leadership skills post	4.02	50	.473	.067
Pair 3	I have good Situation awareness skills pre	3.98	50	.515	.073
	I have good Situation awareness skills post	4.18	50	.482	.068
Pair 4	I have good Communications skills pre	4.10	50	.463	.065
	I have good Communications post	4.26	50	.527	.075
Pair 5	I have good Team working skills pre	4.30	50	.505	.071
	I have good Team working skills post	4.30	50	.505	.071

C22. A table showing Cronbach's alpha for composite NTS

Composite skill	Cronbach's alpha
Decision-making pre	.567
Situation awareness pre	.707
Communication pre	.734
Team working pre	.482
Leadership pre	.657
Decision-making post	.736
Situation awareness post	.750
Communication post	.522
Team working post	.518
Leadership post	.702

C23. A table showing composite NTS analysis pre and post ETS

	N	Sum	Mean	Std. Dev	Skewness		Kurtosis	
						Std. Error		Std. Error
SA Mean pre	50	183.67	3.67	0.502	-0.26	0.337	0.342	0.662
SA Mean post	50	200.33	4.01	0.412	-0.511	0.337	2.664	0.662
DM Mean pre	50	195.25	3.91	0.388	0.776	0.337	0.738	0.662
DM Mean post	50	205.50	4.11	0.365	-0.205	0.337	1.732	0.662
TW Mean pre	50	199.33	3.99	0.398	-0.07	0.337	0.573	0.662
TW Mean post	50	208.33	4.17	0.370	-0.651	0.337	0.849	0.662
Comms Mean pre	50	193.00	3.86	0.457	-0.866	0.337	2.864	0.662
Comms Mean post	50	193.67	3.87	0.503	-0.054	0.337	0.565	0.662
Leader Mean pre	50	189.33	3.79	0.529	-0.498	0.337	0.205	0.662
Leader Mean post	50	200.50	4.01	0.407	-0.628	0.337	2.061	0.662

C24. A table showing Npar Wilcoxon S-R analysis of composite NTS

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles 25th	50th Median	75th
SA Mean pre	50	3.6733	.50165	2.33	5.00	3.3333	3.6667	4.0000
DM Mean pre	50	3.9050	.38759	3.25	5.00	3.5000	4.0000	4.0000
TW Mean pre	50	3.9867	.39818	3.00	5.00	3.9167	4.0000	4.0833
Comms Mean pre	50	3.8600	.45719	2.33	5.00	3.6667	4.0000	4.0000
Leader Mean pre	50	3.7867	.52924	2.33	4.67	3.3333	4.0000	4.0000
SA Mean post	50	4.0067	.41234	2.67	5.00	4.0000	4.0000	4.0833
DM Mean post	50	4.1100	.36478	3.00	5.00	4.0000	4.0000	4.2500
TW mean post	50	4.1667	.37039	3.00	4.67	4.0000	4.1667	4.3333
Comms Mean post	50	3.8733	.50346	2.67	5.00	3.5833	4.0000	4.0000
Leader Mean post	50	4.0100	.40708	2.75	5.00	4.0000	4.0000	4.2500

C25. A table showing primary NTS *p* values

Between subject factors and group size (yes and No)	Current emergency response role (Y=34 *n*=16)		Received Emergency response training (Y=41 *n*=9)		Responded to real emergency (Y=36 *n*=14)		Participated in ETS before (Y=3 *n*=18)	
	Between subject	ETS	Between subject	ETS	Between subject	ETS	Between subject	ETS
Situation awareness	.549	<.001	1.00	.001	.143	.001	.846	<.001
Team working	.138	<.001	.963	.010	.109	.017	.647	.002
Decision-making	.839	.003	.425	.002	.922	.003	.693	.001
Leadership	.469	.006	.919	.031	.692	.023	.549	.006
Communication	.368	.978	.328	.702	.877	.725	.077	.415

C26. A table showing the composite NTS comparison

	N	Sum	Mean	Std. Deviation	Skewness		Kurtosis	
					Statistic	Std. Error	Statistic	Std. Error
C1.1 I find it difficult communicating to people in an effective, efficient and timely manner with all levels (internal, external, individuals and groups)	50	185	3.70	.814	-1.275	.337	2.059	.662
C1.2 I find it difficult communicating to people in an effective, efficient and timely manner with all levels (internal, external, individuals and groups)	50	199	3.98	.685	-1.961	.337	7.775	.662
C2.1 I find that I have the skills to clearly communicate information to people	50	198	3.96	.570	-.699	.337	2.680	.662
C2.2 I find that I have the skills to clearly communicate information to people	50	206	4.12	.594	-.640	.337	2.654	.662
C4.1 I feel confident communicating with all levels (internal, external, individuals and groups)	50	198	3.96	.533	-.888	.337	3.911	.662
C4.2 I feel confident communicating with all levels (internal, external, individuals and groups)	50	207	4.14	.452	.610	.337	1.395	.662
C5.1 I find it difficult to get people to listen to what I have to say	50	183	3.66	.593	-.966	.337	.825	.662
C5.2 I find it difficult to get people to listen to what I have to say	50	197	3.94	.424	-2.060	.337	10.358	.662

DM1.1 I feel confident that I have the skills to make timely decisions	50	200	4.00	.495	.000	.337	1.423	.662
DM1.2 I feel confident I have the skills to make timely decisions	50	208	4.16	.468	.550	.337	.964	.662
DM2.1 I find it difficult to log and document decisions I have made	50	182	3.64	.921	-.513	.337	-.502	.662
DM2.2 I find it difficult to log and document decisions I have made	50	200	4.00	.571	-.684	.337	2.865	.662
DM3.1 I find it difficult to make clear decisive decisions	50	197	3.94	.424	-2.060	.337	10.358	.662
DM3.2 I find it difficult to make clear decisive decisions	50	206	4.12	.480	.357	.337	1.215	.662
DM4.1 I recognise the implications of my actions on myself and others	50	202	4.04	.348	.651	.337	5.874	.662
DM4.2 I recognise the implications of my actions on myself and others	50	208	4.16	.422	1.022	.337	1.409	.662
L1.1 I find I can inspire confidence and keep perspective in the leadership role	50	191	3.82	.596	-.536	.337	1.159	.662
L1.2 I find I can inspire confidence and keep perspective in the leadership role	50	199	3.98	.622	-1.046	.337	3.265	.662
L3.1 I find it difficult to plan and prioritise	50	191	3.82	.774	-1.321	.337	3.254	.662
L3.2 I find it difficult to plan and prioritise	50	204	4.08	.601	-2.380	.337	14.009	.662
L4.1 I find it difficult manage workload and resources	50	182	3.64	.749	-.502	.337	.130	.662
L4.2 I find it difficult manage workload and resources	50	198	3.96	.450	-1.588	.337	8.523	.662
L5.1 I have the skills to motivate people to perform and follow my direction	50	195	3.90	.505	-1.188	.337	4.380	.662
L5.2 I have the skills to motivate people to perform and follow my direction	50	201	4.02	.553	.013	.337	.499	.662
SA1.1 I feel confident in my ability to gather and understand information to develop situation awareness	50	197	3.94	.550	-.808	.337	3.152	.662
SA1.2 I feel confident in my ability to gather and understand information to develop situation awareness	50	207	4.14	.572	-.667	.337	3.364	.662
SA2.1 I lack the confidence in my ability to consider, reassess and reject options	50	174	3.48	.814	-.878	.337	-.501	.662

SA2.2 I lack the confidence in my ability to consider, reassess and reject options	50	201	4.02	.553	-.742	.337	3.579	.662
SA3.1 I feel I am able to project and anticipate future states to maintain situation awareness	50	172	3.44	.705	-.508	.337	-.328	.662
SA3.2 I feel I am able to project and anticipate future states to maintain situation awareness	50	199	3.98	.428	-.125	.337	2.948	.662
SA4.1 I find it difficult to maintain situation awareness	50	182	3.64	.631	-1.064	.337	.857	.662
SA4.2 I find it difficult to maintain situation awareness	50	195	3.90	.505	-1.188	.337	4.380	.662
TW1.1 I prefer to work individually than be part of team	50	121	2.42	.859	1.062	.337	1.880	.662
TW1.2 I prefer to work individually than be part of team	50	115	2.30	.863	1.151	.337	1.427	.662
TW2.1 I find it difficult to use authority and assertiveness as part of a team	50	183	3.66	.772	-1.257	.337	.766	.662
TW2.2 I find it difficult to use authority and assertiveness as part of a team	50	192	3.84	.584	-1.895	.337	4.737	.662
TW3.1 I feel confident working as part of a team	50	214	4.28	.497	.478	.337	-.565	.662
TW3.2 I feel confident working as part of a team	50	225	4.50	.505	.000	.337	-2.085	.662
TW4.1 I feel I have the ability to coordinate activities and exchange information as part of a team	50	201	4.02	.428	.125	.337	2.948	.662
TW4.2 I feel I have the ability to coordinate activities and exchange information as part of a team	50	208	4.16	.468	.550	.337	.964	.662
TW5.1 I find it difficult to maintain team focus	50	189	3.78	.545	-1.682	.337	3.411	.662
TW5.2 I find it difficult to maintain team focus	50	196	3.92	.601	-1.739	.337	5.249	.662

C27. A table showing a paired sample t-test

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DM1.1 I feel confident that I have the skills to make timely decisions	4.00	50	.495	.070
	DM1.2 I feel confident I have the skills to make timely decisions	4.16	50	.468	.066
Pair 2	DM2.1 I find it difficult to log and document decisions I have made	3.64	50	.921	.130
	DM2.2 I find it difficult to log and document decisions I have made	4.00	50	.571	.081
Pair 3	DM3.1 I find it difficult to make clear decisive decisions	3.94	50	.424	.060
	DM3.2 I find it difficult to make clear decisive decisions	4.12	50	.480	.068
Pair 4	DM4.1 I recognise the implications of my actions on myself and others	4.04	50	.348	.049
	DM4.2 I recognise the implications of my actions on myself and others	4.16	50	.422	.060
Pair 5	SA1.1 I feel confident in my ability to gather and understand information to develop situation awareness	3.94	50	.550	.078
	SA1.2 I feel confident in my ability to gather and understand information to develop situation awareness	4.14	50	.572	.081
Pair 6	SA2.1 I lack the confidence in my ability to consider, reassess and reject options	3.48	50	.814	.115
	SA2.2 I lack the confidence in my ability to consider, reassess and reject options	4.02	50	.553	.078
Pair 7	SA3.1 I feel I am able to project and anticipate future states to maintain situation awareness	3.44	50	.705	.100
	SA3.2 I feel I am able to project and anticipate future states to maintain situation awareness	3.98	50	.428	.061
Pair 8	SA4.1 I find it difficult to maintain situation awareness	3.64	50	.631	.089
	SA4.2 I find it difficult to maintain situation awareness	3.90	50	.505	.071
Pair 9	C1.1 I find it difficult communicating to people in an effective, efficient and timely manner with all levels (internal, external, individuals and groups)	3.70	50	.8144	.1152
	C1.2 I find it difficult communicating to people in an effective, efficient and timely manner with all levels (internal, external, individuals and groups)	3.98	50	.685	.097
Pair 10	C2.1 I find that I have the skills to clearly communicate information to people	3.96	50	.570	.081
	C2.2 I find that I have the skills to clearly communicate information to people	4.12	50	.594	.084
Pair 11	C4.1 I feel confident communicating with all levels (internal, external, individuals and groups)	3.96	50	.533	.075
	C4.2 I feel confident communicating with all levels (internal, external, individuals and groups)	4.14	50	.452	.064
Pair 12	C5.1 I find it difficult to get people to listen to what I have to say	3.66	50	.593	.084
	C5.2 I find it difficult to get people to listen to what I have to say	3.94	50	.424	.060
Pair 13	TW1.1 I prefer to work individually than be part of team	2.42	50	.859	.122
	TW1.2 I prefer to work individually than be part of team	2.30	50	.863	.122

Pair 14	TW2.1 I find it difficult to use authority and assertiveness as part of a team	3.66	50	.772	.109
	TW2.2 I find it difficult to use authority and assertiveness as part of a team	3.84	50	.584	.083
Pair 15	TW3.1 I feel confident working as part of a team	4.28	50	.497	.070
	TW3.2 I feel confident working as part of a team	4.50	50	.505	.071
Pair 16	TW4.1 I feel I have the ability to coordinate activities and exchange information as part of a team	4.02	50	.428	.061
	TW4.2 I feel I have the ability to coordinate activities and exchange information as part of a team	4.16	50	.468	.066
Pair 17	TW5.1 I find it difficult to maintain team focus	3.78	50	.545	.077
	TW5.2 I find it difficult to maintain team focus	3.92	50	.601	.085
Pair 18	L1.1 I find I can inspire confidence and keep perspective in the leadership role	3.82	50	.596	.084
	L1.2 I find I can inspire confidence and keep perspective in the leadership role	3.98	50	.622	.088
Pair 19	L3.1 I find it difficult to plan and prioritise	3.82	50	.774	.110
	L3.2 I find it difficult to plan and prioritise	4.08	50	.601	.085
Pair 20	L4.1 I find it difficult manage workload and resources	3.64	50	.749	.106
	L4.2 I find it difficult manage workload and resources	3.96	50	.450	.064
Pair 21	L5.1 I have the skills to motivate people to perform and follow my direction	3.90	50	.505	.071
	L5.2 I have the skills to motivate people to perform and follow my direction	4.02	50	.553	.078